A Dissertation on

A STUDY TO CORRELATE INCIDENCE & ASSOCIATION OF SENSORINEURAL HEARING LOSS & RETINOPATHY IN PATIENTS WITH DIABETES MELLITUS

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DECLARATION

I, **Dr. SANTOSH KUMAR**, solemnly declare that the dissertation, titled **"A STUDY TO CORRELATE INCIDENCE & ASSOCIATION OF SENSORINEURAL HEARING LOSS & RETINOPATHY IN PATIENTS WITH DIABETES MELLITUS"** is a bonafide work done by me during the period of August 2014 to July 2015 at Government Stanley Medical College and Hospital, Chennai under the expert supervision of **PROF. Dr. T. BALASUBRAMANIAN, M.S., D.L.O.,** Professor and Head, Department Of Otorhinolaryngology , & **PROF. Dr. F. ANTHONY IRUDHAYA RAJAN M.S.,D.L.O,** Professor and Chief of ENT UNIT II of Otorhinolaryngology**,** Government Stanley Medical College and Hospital, Chennai.

This dissertation is submitted to The Tamil Nadu Dr. M.G.R. Medical University in partial fulfilment of the rules and regulations for the M.S. degree examinations in Otorhinolaryngology to be held in April 2016.

Date: **Dr. SANTOSH KUMAR**

Place: Chennai-01

CERTIFICATE

This is to certify that the Dissertation - **"A STUDY TO CORRELATE INCIDENCE & ASSOCIATION OF SENSORINEURAL HEARING LOSS & RETINOPATHY IN PATIENTS WITH DIABETES MELLITUS"** presented by **Dr. SANTOSH KUMAR**, is an original work done in the Department of Otorhinolaryngology, Government Stanley Medical College and Hospital, Chennai in partial fulfillment of regulations of the Tamil Nadu Dr. M.G.R. Medical University for the award of degree of M.S. (Otorhinolaryngology) Branch IV, under my supervision during the academic period 2013-2016.

THE DEAN
STANLEY MEDICAL COLLEGE
CHENNAI-01

PROF.Dr.T.BALASUBRAMANIAN
HEAD OF THE DEPARTMENT OF ENT
GOVT STANLEY MEDICAL COLLGE
CHENNAI- 01.

PROF. Dr. F. A ANTHONY IRUDHAYA RAJAN M.S.,D.L.O
CHIEF OF ENT UNIT II
GOVT STANLEY MEDICAL COLLEGE
CHENNAI-01.

DATE:

PLACE:

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LIST OF ABBREVIATIONS

AGE	advanced glycation end product
CBC	Complete blood count
CNS	Central nervous system
CSME	Clinically significant macular edema
CWS	Cotton wool spot
dB	Decibel
DD	Disc diameter
DM	Diabetic mellitus
DR	Diabetic retinopathy
ETDRS	Early treatment diabetic retinopathic study group
FAZ	Foveal avascular zone
FBS	Fasting blood sugar
FFA	Fundus fluorescein angiograph
HbA1C	Glycated hemoglobin
HDL	High density lipid profile
Hz	Hertz
IDDM	Insulin dependent diabetes mellitus
IRMA	Intra retinal microvascular abnormality
LDL	Low density lipid profile
NPDR	Non proliferative diabetic retinopathy

PAS	Periodic acid Schiff
PDR	Proliferative diabetic retinopathy
PPBS	Post prandial blood sugar
PTA	Pure tone audiometry
PKC	Protein kinase
SNHL	Sensorineural hearing loss.
WHO	World health organization

ABSTRACT

AIM: To evaluate incidence of sensorineural hearing loss & retinopathy in patients with diabetes mellitus. To correlate association of_sensorineural hearing_loss with retinopathy in patients with diabetes mellitus.

METHOD AND MATERIAL: A sample of 92 subjects are selected by blind randomization & divided into cases & controls of 46 individuals in each. Detailed clinical examination of ear & eye is performed, including tunning fork tests fundoscopy & subjected to investigations. The data collected from these tests & investigations are subjected to appropriate statistical tests to arrive suitable conclusions.

RESULT: In our study 73.9% of cases had diabetic retinopathy and 89% of cases had sensory neural hearing loss with significant P value.

60.8% cases with >2years of DM had retinopathy. About 39.1% cases of retinopathy had DM for >4 years. 4 out of 5 cases of PDR had DM > 6 years.

65.2% of cases with SNHL had DM > 2years of which 41.3% cases with SNHL had DM >4 years.

Cases with HbA1C >7, 71.7% of them had retinopathy of which 43.47% of them had HbA1C >8. Similarly 84.7% of cases having SNHL had HbA1C >7 of which 41.35% had HbA1C >8.

47.8% of cases having SNHL >41dB (>/=moderate SNHL) had retinopathy of grade 2 NPDR or higher severity of retinopathy. It is highly significant that diabetics with greater SNHL have more severe retinopathy with **P value: - <0.01.**

CONCLUSION: A statistically significant correlation was found between SNHL and the severity of diabetic retinopathy. More severe grades of SNHL and retinopathy manifesting in patients with higher levels of HbA1C and prolonged duration of DM.

KEY WORDS: relationship between SNHL and diabetic retinopathy, SNHL among diabetics with retinopathy, PTA and fundoscopy in diabetics.

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INTRODUCTION

Auditory & visual senses being the most important sense organs among the five, are needed almost for every day to day activities in our life. Any condition or disease causing impairment in hearing & vision can disturb the normal well being of an individual. One of such disease is Diabetes mellitus.

India has 2nd largest diabetics in the world according to WHO (61.3 million, or 8% of the population).[6.] And the number is expected to increase to a staggering 79.4 million by 2030.

Diabetes mellitus is a metabolic disorder, due to relative or absolute lack of insulin resulting in elevated blood glucose levels associated with long term vascular and neurological complications.[5.] It affects almost all the systems in the body to its severity if left uncontrolled. Likewise, diabetic hearing loss results from microangiopathic involvement of endolymphatic sac and/or basilar membrane vessels.[4.] The typical hearing loss in diabetes is described as a progressive, bilateral, sensorineural type deafness of gradual onset which affects predominantly higher frequencies and elderly patients. There is a decrease in auditory acuity which is similar to that due to presbyacusis, but those affected show a hearing loss greater than that could be expected at that age.[2,3.] Exceptions to this pattern have been reported including acute onset of hearing loss or associated with Meniere like attacks, unilateral deafness with or without vestibular symptoms and low frequency involvement.

The effect of diabetes mellitus on hearing is known since 1857, when Jordao first showed hearing loss in a patient with incipient diabetic coma. [1.]

The retina is affected by many systemic disorders, one of which is diabetes mellitus (DM). An exponential increase in the global number of diabetic patients couples with a rise in life expectancy due to better medical care, has resulted in a proportionate rise in long term vascular complications such as diabetic retinopathy (DR).

Diabetes mellitus is a major cause of avoidable blindness in both the developing and the developed countries. Patients with diabetic retinopathy (DR) are 25 times more likely to become blind than non-diabetics

Diabetic retinopathy is a highly specific microvascular complication of diabetes and is characterized by abnormal retinal vascular permeability, microaneurysm formation, capillary and arteriolar closure, neovascularization and associated haemorrhage, scarring, and tractional retinal distortion and detachment.

Diabetic retinopathy is the commonest cause of blindness in the working population, causing an estimated 50-65 new cases of blindness per 1,00,000 people every year.[7, 8.]

This case control study is done to compare auditory acuity & retinopathy in non-diabetic & diabetic patients to find out the affect of diabetes on auditory acuity.

AIM OF THE STUDY

1. To evaluate incidence of sensorineural hearing loss & retinopathy in patients with diabetes mellitus.

2. To correlate association of sensorineural hearing loss with retinopathy in patients with diabetes mellitus.

OBJECTIVE OF THE STUDY

1. To correlate sensorineural hearing loss & retinopathy with duration of disease.

2. To correlate incidence of sensorineural hearing loss & retinopathy according to age & sexual predominance in diabetes mellitus.

3. To correlate severity SNHL & retinopathy according to glycemic control (HbA1c).

4. To asses association between retinopathy with sensory neural hearing loss among diabetics.

REVIEW OF LITERATURE

Historical review:

A. DIABETES MELLITUS

YEAR	EVENT
Over 3500 years -	Polyuric states similar to diabetes mellitus were described.
	The name Diabetes came from the Greek word for a 'syphon'
First millennium -	The sweet taste of urine was recognized
1776 -	Mathew Dobson stated that diabetes was a systemic condition and not a disease of the kidney and that diabetic
	urine and serum tasted sweet
Eighteenth century -	John Rollo added 'mellitus' meaning 'honeyed'
1815 -	Chevreul identified excess sugar in diabetes as glucose.
1840 -	Claude Bernard showed that glucose was normally present in the body and is stored in the liver as glycogen and is secreted into the blood stream during fasting.
1864 -	Marchal de calvi identified the association of neuropathy with diabetes mellitus.

1869 -	Paul Langerhans showed the production of an internal secretion in the pancreas which could regulate glucose metabolism.
1880 -	Etienne Lancereaux divided diabetes into diabetes maiqre (lean subject) and diabetes obese gras (obese)
1880 -	Stephan Mackenzie and Edward Nettleship identified specific lesions microaneurysm in blood vessels.
1889 -	Oscar Minkowski and Josef von Mering demonstrated the role of pancreas in diabetes by producing diabetes in a dog by pancreatectomy.
1893 -	Gustave Laguesse showed that pancreatic islets produced internal secretions that regulated glucose metabolism
1900-1920	Georg Zuelzer and Nicholas Pauluco attempted to isolate Insulin
1909 -	Jean de Meyer gave the name 'insulinine' to the then hypothetical products of the islets.
1921 -	Fredrick Banting, Charles Best and James Collip discovered insulin at the university of Toronto in acid-ethanol extracts of pancreas and won the Nobel prize in 1995

1930 -	Wilhelm Falter and Harold Hims classified diabetes into ‘insulin sensitive’ and ‘insulin nonsensitive’ types.
1940 -	Production of synthetic human sequence insulin.
1950 -	Kund Lundbaek described a particular type of angiopathy that was specific to diabetes.
1955 -	Frederick Sanger and Dorothy Hodgkin described the primary sequence of insulin
1956 -	Rosalyn Yalow and Solomon Berson invented the radioimmunoassay for insulin.
1965 -	Willy Gepts highlighted the significance of chronic lymphocytic infiltrations in the islets of Langerhans.
1969 -	Fredrick Sanger and Dorothy Hodgkin described the molecular three dimensional structure of insulin.
1971 -	Pierre Freyet discovered the presence of insulin receptors.
1974 -	Robert Tattersall described MODY as a distinct variant of diabetes mellitus.
1980 –	Graham Bell described the sequence of human insulin gene.

B. OTOLOGICAL ASPECT:

6th century BC -	Pythagoras, a philosopher and a mathematician, reasoned that sound was a vibration in the air.
175 AD -	Galen, a Greek physician recognized that nerves transmitted the sensation of sound to the brain.
1200 AD -	Recognition of the fact that sounds entered the interior of the ear via the eardrum and exited on its journey to the brain via the auditory nerve.
1543 AD -	Vesalius described the ossicles and applied the name 'labyrinth' to the ear.
1550 AD -	Eustacius described the pharyngo tympanic tube.
1561 AD -	Gabriello Fallopio, an Italian professor discovered the 'cochlea'.
1600 AD -	Felix Platter, a physician from Switzerland studied of the bones of the ear and commented on the phenomena of conduction of sound through the bones of the head. He said that the cause of deafness was sometimes in the brain (sensorineural or central deafness) and sometimes in the cavity of the ear (conductive).

1640 AD -	Willis of England described the cranial nerves and said that the tympanic membrane was set into motion by sounds and the vibrations thus set up were transferred to the inner ear and to the auditory nerves.
1704 AD -	Valsalva divided the ear into three anatomical parts and developed the Valsalva's maneuver.
1800 AD	Cotugno discovered the fluids of the inner ear and described the fibers of the basilar membrane.
1801 AD	Flourens of Paris, discovered the action of semicircular canals and suggested that the 'nerve for hearing' had two branches, one for hearing and one for balance.
1825 AD	Weber worked with tuning forks for testing hearing and the test was later called 'Weber's test'.
1851AD	Alfonso Corti, an Italian anatomist discovered that the organ within the cochlea is the true centre for hearing which is now named as 'organ of Corti'. He also caught a glimpse of the thousands of hair cells that are now known to be the central elements in the hearing apparatus.
1855 AD	Rinne tests hearing using tuning forks and calls it 'Rinne's test'

1857 AD	Hermann von Helmholtz reasons that the sound of different frequencies are detected at different sections of the organ of corti and publishes his 'tonal theory of hearing' which states that the parts nearest to the ossicles are sensitive to high tones and parts further from the ossicles to low tones.
1941 AD	Barany in Vienna, wins the NOBEL PRIZE for developing methods of testing the organ of balance that would enable the clinician to differentiate between tumors of the vestibulocochlear nerve and neuronitis of the vestibular end organ and physiological nystagmus.
1928 AD	Georg von Bekesy, an engineer for the Hungarian telephone exchange system, begins to use large scale models of cochlea to determine precisly how sounds of different frequencies stimulate basilar membrane and won NOBEL PRIZE.

C. AUDIOLOGICAL ASPECT

1897 AD	1st basic model for a pitch range audiometer was developed by Seashore in Iowa.
1947 AD	Bekesy introduced a technique for semi automatic audiometry which found application in both standard threshold determination and site of lesion testing.

1957 AD	Cahart added the tone decay test to the site of lesion test battery.
1960 AD	Ruben et al. recorded cochlear potentials and compound action potentials of vestibulo-cochlear nerve.
1967 AD	Bocca and Calero reported the methods of clinical identification and evaluation of central auditory deafness.

C. DIABETIC RETINOPATHY ASPECT:

1846	French ophthalmologist and Professor of Hygiene in Paris, Appolinaire Bouchardat reported the development of visual loss in the absence of cataract in diabetics.
1851	Herman Von Helmholtz introduced the first ophthalmoscope. Eduard Jäger who constructed an instrument which integrated in one apparatus the principles of Helmholtz's, Ruete's and other ophthalmoscopes.
1855	Jäger was the first to observe diabetic macular changes.
1869	Henry Noyes published an article in the USA supporting the link between diabetes mellitus and maculopathy.

1876	Edward Nettleship presented the first histopathological proof of a cystoids degeneration of the macula in diabetic patients
1890	Julius Hirschberg in 1890, classified diabetic retinopathy into four types (retinitis centralis punctuate, haemorrhagic form, retinal infarction and haemorrhagic glaucoma), thus describing the full natural history of diabetic retinopathy.

REVIEW OF LITERATURE

Around 278 million people in the world have moderate to profound hearing loss,[11.] and have proved that more than half of the cases can be prevented by early diagnosis and management. Hearing loss which has a marking impact on an individual, families, health system and a country can be managed by provision of hearing aids after a precise diagnosis. The pathetic situation is that one out of the forty deaf in a developing country, gets a hearing aid, of which India is one.[11.]India takes a big bite in the diabetic population of the world with 50 million people.[12.] The Indian population with an increased susceptibility to diabetes mellitus is expected to double by 2030.[11]

Occurrence of hearing loss in diabetes mellitus patients is known since1857, when Jordao reported hearing loss in a patient with incipient diabetic coma.[1] The diabetic influence on sensory neural hearing loss has been studied by Jorgen (1961)[52] with aid of temporal bone of diabetic patients and reported a condition unique to diabetes mellitus as accumulation of Periodic Acid Schiff (PAS) positive substance in the modiolus vessels and capillaries of stria vascularis in various degrees.[10] The study was carried over by Costa (1961) in animal models. With no particular pathological localization there was increase in the thickness of the basement membrane of the capillaries in stria vascularis and the changes were not bilateral. No changes were found in the spiral ligament. The basal cell layer was found disorganized and

vacuolization of light cells were found. In some turns of cochlea there was certain degree of degeneration of the endothelial cells of vestibular margin. With advent of 8 months of diabetic duration, the external sulcus cells of basal turns showed degenerative changes. The organ of corti, ganglion cells or nerve fibres showed no structural changes. Temporal bone sections showed increased thickness in vessel walls of modiolus. The endothelial cells were swollen and the basement membrane was much thicker when compared to normal control rats. The changes were not at all related to the duration of diabetes.[14] Zelenka & Kzak denied the significance of hearing loss in diabetics with the duration of disease, age of the patient, blood sugar level, blood pressure, bleeding in labyrinthine vessels which was postulated at that period.[15] The spiral ganglion was found atrophied in the middle turn of cochlea. Fibrous thickening and narrowing of the lamina were observed in small arteries of internal auditory canal and in the capillaries of stria vascularis.

The detailed study about pathological changes of the inner ear and central auditory pathway in diabetics was studied by Makishima and Tanaka.[16] Rust restricted his study to type 2 diabetics and degree of inner ear damage. He suggested that outer hair cell loss was prominent and was related to hyperglycemia, especially in patients who had genetic predisposition to glucose intolerance. The diabetic neuropathy in the auditory system was attributed to microangiopathy[13] by Proctor in 1977, based on the hypothesis

that peripheral and central neuropathies in diabetes mellitus may affect vestibular neurons. Later Friedman studied diabetic patients with no complaints of decreased hearing and found a 55% prevalence of sensorineural hearing loss involving at least one frequency.[18] This study revealed that sensorineural hearing loss was untouched by the age of the patient and the hearing loss was similar at low and high frequencies adding to the contradictory views. Diabetic patients have poorer hearing thresholds than non diabetics.[19]

Diabetic retinopathy, one of the early manifestations of the late complications of diabetes mellitus was studied in relation to hearing loss by Miller and postulated that there was no significant difference in the hearing threshold from those of the control[12]

population, but poor speech perception in the diabetic group was observed.[20] The subtle retrocochlear hearing loss was denied by brain stem evoked responses in diabetics and non diabetics. Diabetics with peripheral neuropathy in association to sensorineural hearing loss was carried out by Mehra and observed a prevalence of 25%.[21] In the brainstem auditory evoked responses waves III , IV and V were delayed in diabetics in comparison to the control population.

The clinical and histopathlogical correlation in hearing loss established diabetics was studied by Wackym and observed that diabetics had more

hearing loss than the control of same age group. The diabetic group with hearing loss had microangiopathy.[4] In 1989 Kurien studied the variation in hearing threshold in diabetics and published his study result as poor control of blood sugar levels and complicated diabetic history had high frequency hearing loss in comparison with well controlled diabetic history. No correlation of hearing threshold and diabetic duration was found.[22]

Various factors that are responsible for hearing loss in diabetics are duration of diabetes, age, sex, etc. Certain studies show positive correlation between duration of diabetes and hearing loss[3], but some say it has no relation.[2,22] The reason stated for having no relation is that microangiopathy, does not depend on duration, but on control of diabetes. If there is poor control of diabetes, then hearing threshold increases.[2]

In 1993 Cullen and Cinnamon compared hearing loss in insulin dependent diabetics and controls of same age and sex. They reported that there was a increased male morbidity involving variable frequencies and duration of diabetes having no effect on the hearing threshold.[2] The typical hearing loss in diabetes mellitus is slowly progressive, bilateral sensorineural hearing loss affecting higher frequencies.[2,23]

But, that of, sudden onset unilateral Sensorineural hearing loss affecting lower frequencies is also found in some cases of diabetes mellitus.[2,23]

Certain studies state that increase in hearing threshold in diabetics is for low frequencies (500 Hz), but some authors say it is present only in high frequencies (6000Hz and 8000Hz).[2] The study showing positive correlation in low frequencies was conducted in IDDM patients, it was drawn that insulin might limit the progression of hearing threshold in higher frequencies. This finding of sensorineural hearing loss in diabetics indicated a disturbance somewhere in the central auditory pathway or in the inner ear.[3]

To show the direct evidence of poor metabolic control over sensorineural hearing loss, levels of fasting blood glucose and HbA1C were measured at the time of conducting audiometry. But their levels were not systematically associated with elevated threshold of 6000 and 8000Hz.[3] But poor metabolic control have indirect effects like diabetic retinopathy and nephropathy which are clearly associated with sensorineural hearing loss.

The three main theories of pathogenesis of hearing impairment in diabetics are angiopathy, neuropathy and alterations in the inner ear glucose levels.[3,24] There is also a possibility of hair cell dysfunction in diabetics as suggested by vascular thickening around endolymphatic sac causing accumulation of toxic waste products in endolymph.[2]

P.C.Chamyal advocated 40% sensorineural hearing loss prevalence in diabetics, involving higher frequencies and duration of diabetes had no effect on the hearing threshold.[25] In 1998 Aggarwal opined through his study that in diabetics with hearing loss there was 64% sensorineural and 21% conductive component.[26]

Sensorineural hearing impairment results from disorders of the cochlea, eighth cranial nerve, or cochlear nuclei. Generally sensorineural hearing impairment is irreversible and usually cannot be alleviated surgically or by medical intervention.[31]

Sensorineural hearing impairment is usually managed through aural rehabilitation or habilitation including amplification.[31] The acquired causes of sensorineural hearing loss are:[32]

Acquired causes of SNHL

1. Idiopathic

2. Trauma

3. Drugs (aminoglycosides, furosemide, salicylates, cisplatinum, quinine, thalidomide)

4. Noise induced

5. Aging

6. Systemic disease (hypothyroidism, chronic renal failure, diabetes mellitus)

7. Infection

8. Acoustic schwannomas

Out of this the present study aims at type 2 Diabetes Mellitus in the middle age group.

TYPE II DIABETES MELLITUS [27,34]

Type II DM, is the predominant form of diabetes world wide accounting for 90% of cases.[35] It has reached an epidemic status in both developed and developing countries and has become one of the world's most important public health problems.[36]

Sex, age and ethnic background are important factors in determining the risk for the development of type II DM. It appears that this disorder is more common in females.

The World Health Organization[34] has laid down strict criteria for the diagnosis of DM which are:

1. Symptoms of diabetes mellitus (polyuria, polydypsia, and weight loss) plus a random blood sugar of greater than or equal to 200mg/dl (on at least two separate occasions) OR

2. Fasting blood sugar greater than or equal to 126mg/dl on at least two separate occasions. OR

3. Two hour plasma glucose greater than or equal to 200mg/dl during an oral glucose tolerance test.

The pathogenesis of type II DM is complex and involves interaction of genetic and environmental factors. It essentially comprises of three cardinal abnormalities: [33]

- Peripheral insulin resistance,
- Defective insulin secretion,
- Increased glucose production.

There is an emerging consensus that most of the common forms of type II DM are due to a combination of insulin secretion abnormality and insulin resistance. In other words, diabetes results in a genetically predisposed individual with pancreatic beta cells that is unable to adapt to the reductions in insulin sensitivity that occur over a lifetime of the individual and is related to puberty, pregnancy, sedentary life style and over eating leading to obesity.

Clinically, the sequence noted is initial normal plasma glucose levels despite demonstrable insulin resistance. This is followed by worsening resistance leading to post prandial hyperglycemia. Finally, a decreasing insulin secretion and an unchanged insulin resistance lead to fasting hyperglycemia and overt diabetes. It has been observed that most of the insulin resistance is of the post receptor type. Insulin resistance is a consistent finding and is present years before the onset of diabetes. It implies the presence of an impaired biological response to either exogenously administered or endogenously secreted insulin.

The disposal of glucose after a meal depends on the ability of insulin to increase peripheral glucose uptake and simultaneously decrease endogenous glucose production. It appears that in type II DM, there is a defect in the regulation of glucose production from the liver which utilizes glycogenolysis and gluconeogenesis to produce glucose.[34] Under different conditions and at different times in the post prandial

period, the contribution of each of these pathways to maintain glucose may vary. Chronic complications of diabetes mellitus may affect multiple organ systems and are responsible for majority of morbidity and mortality associated with disease.

They are divided into:

1. MICROVASCULAR

a. Neuropathy

- Sensory and motor

- autonomic

b. Eye Disease

- Retinopathy (proliferative , non proliferative)

- Macular edema

c. Nephropathy

2. MACROVASCULAR

a. Coronary artery diseases

b. Peripheral Vascular diseases

c. Cerebro vascular diseases

3. MISCELLANEOUS

a. Gastro instestinal

b. Genitourinary

c. Dermatologic manifestations

d. Infectious diseases

e. Cataract

f. Glaucoma

g. Hearing loss

The risk of chronic complication increase as a function of duration of hyperglycemia which becomes apparent in the second decade of hyperglycemia. As type II diabetes mellitus has a long asymptomatic period these patients are diagnosed mostly based on the complications. Randomised clinical trials have demonstrated that a reduction chronic hyperglycemia prevents or delays neuropathy, retinopathy or nephropathy. Genetic susceptibility to develop the particular complications have also been implicated.

The complication of DM, are underlined by three pathological mechanisms namely, microangiopathy, neuropathy, or a combination of both.[28] The diabetic specific microangiopathy is seen in the retina and the renal glomerulus along with the peripheral vascular circulation. Its role in microcirculation of the inner ear is controversial. Diabetes is also associated with an accelerated atherosclerotic macrovascular disease which is more extensive and progressive. Several studies have demonstrated a strong

relationship between glycemia and diabetic microvascular complications. This is continuous though not linear in nature.

Chronic hyperglycemia is the central initiating factor for all types of diabetic microvascular disease.[34] The duration, magnitude of hyperglycemia are both strongly correlated with the rate and extent of progression of microvascular disease. It appears that hyperglycemic damage is limited to those cell types that develop intra cellular hyperglycemia for example, endothelial cells. These cells cannot down regulate glucose transport when exposed to extracellular hyperglycemia.

Applied Anatomy of Inner Ear [35]

The inner ear or labyrinth is situated in the petrous part of temporal bone and is divided into bony and membranous parts. The bony labyrinth houses the sensory organs and soft tissue structures of the inner ear and consists of cochlea, three semicircular canals and vestibule. Its bone has three layers, inner endosteal, middle enchondral and outer periosteal layers. The membranous labyrinth contains the sensory epithelium of cochlea and vestibular structures and it lies within the cavities of bony labyrinth.

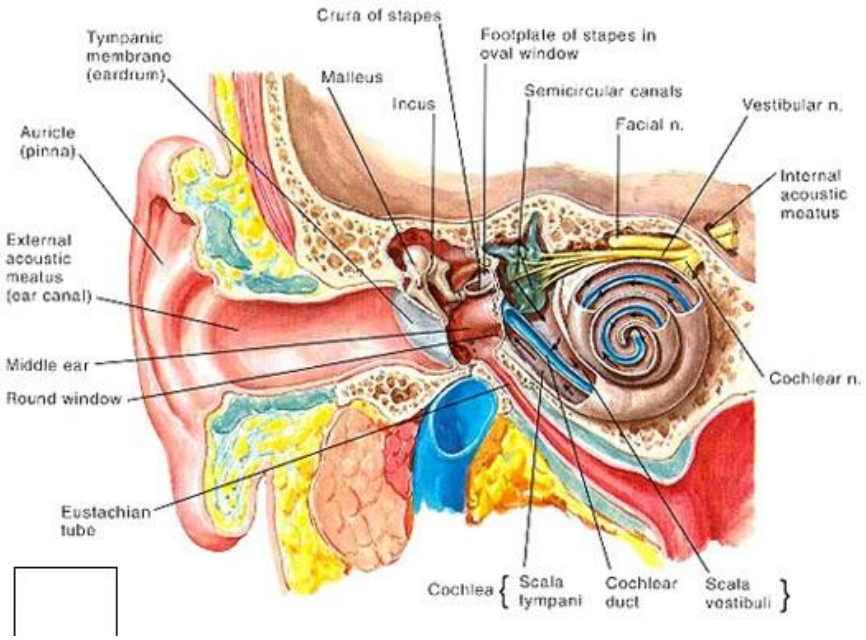


Figure-1:structure of ear.

Cochlea :

The bony cochlea is a coiled tube lying in front of the vestibule and has an external appearance as that of snail. It spirals two and half turns about its central axis, the modilous, and has a height of 5mm. The apex of the cochlea faces laterally and forwards towards the upper part of the medial wall of the tympanic cavity, while the basal coil forms the bulge of the promontory.

Bony spiral lamina is a thin shelf of bone arising from the modiolus that spirals upwards within the lumen of cochlea. The membranous spiral lamina extends from edge of bony spiral lamina to the outer wall of cochlea, thereby dividing each coil into the major portions, scala vestibuli superolaterally and scala tympani inferomedially. Between these two is the part of membranous labyrinth, scala media.

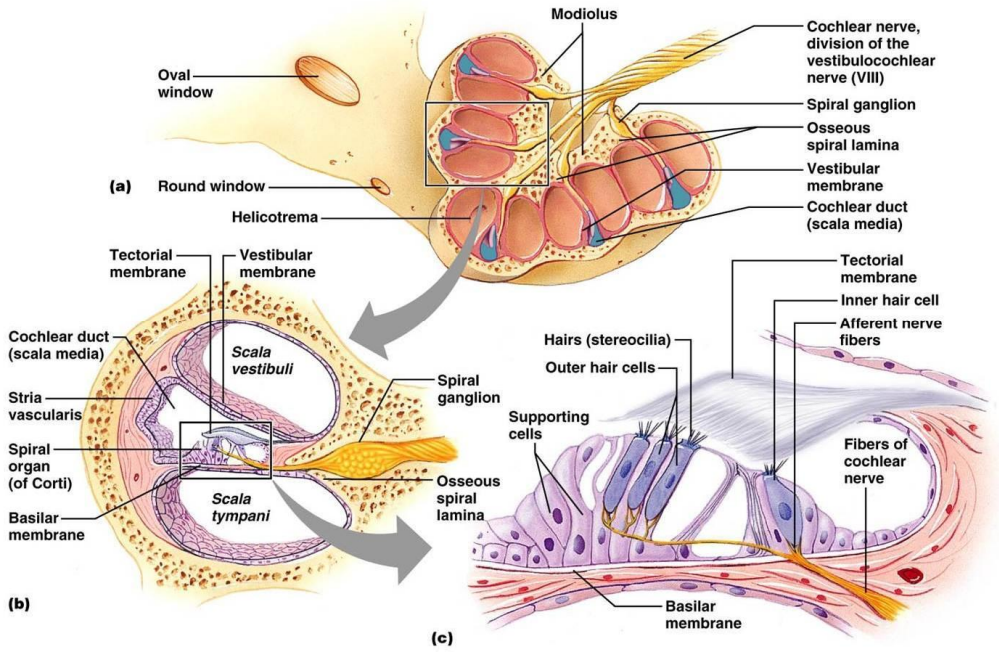


Figure-2: cross section of cochlea.

The cochlea begins as an anterior periotic extension from the vestibule known as the scala vestibuli, that extension, is completely separated from scala tympani at that area by osseous spiral lamina, basilar membrane and spiral ligament. These structures inscribed a hook from the central axis of the cochlea and ultimately end at the inferolateral floor of the vestibule, adjacent to the otic capsule inferior to the oval window and posterior to the round window. The scala media end in this area in an osseous fossa known as cochlear recess of the vestibule. Into this recess fits a clusion of spiral ligament and the blind sac end of scala media known as the vestibular caecum.

At the cochlear base, the scala vestibuli opens into the vestibule with the fenestra vestibuli and stapes footplate close by on the lateral wall of vestibule. The scala tympani is a blind end tube but has in its floor fenestra cochleae closed by the round widow. There is a communication between scala vestibuli and scala tympani and this is called helicotrema.

Cochlear Duct (Scala Media) :

It consists of a spirally arranged tube lying on the upper surface of the spiral lamina against the outer wall of the bony canal of the cochlea. The average length of the cochlea is around 34mm. Section of the cochlear duct is triangular with the floor formed by outer part of bony spiral lamina and all of the membranous spiral lamina and roof formed by sloping Reissner's membrane

Lateral Wall of Cochlear Duct :

It consists of spiral ligment, stria vascularis, spiral prominence and the cells of the outer sulcus. The spiral ligament is a thickened band of connective tissue that is firmly attached to lateral wall of the bony cochlear capsule. It provides support and points an anchorage for both Reissener's membrane and basilar membrane and is thought to be the main source of perilymph. The stria vascularis is highly differentiated metabolically active tissue. The endocochlear potential of +80 to +100v generated by stria vascularis. The stria is also believed to be the source of endolymph.

Roof of Cochlear Duct :

The vestibular wall of cochlear duct is formed by Reissener's membrane. It extends obliquely between the vestibular crest of spiral ligament and the spiral limbus and separates scala vestibuli from scala media. Its endolymphatic surface consists of a layer of epithelial cells and perilymphatic surface, a layer of connective tissue cells. The epithelial cells are attached to each other by tight junctions, that prevents the paracellular passage of molecules but is permeable to water.

Floor of Cochlear Duct :

The tympanic wall of cochlear duct is formed by basilar membrane and spiral limbus. It is largely acellular and consists, primarily of a middle layer of radially oriented filaments that are continuous with the supporting bundle of spiral ligament and spiral limbus.

The basilar membrane play an important role in mechanical analysis and spatial representation of the sound. The elasticity of basilar membrane decreases hundred fold from its basal to apical ends. Because of this variation in stiffness, the location of the maximal deflection of the basal membrane varies frequency. High frequencies cause maximal deflections at the stiff basal end and low frequencies occur progressively towards the more elastic apex.

The spiral limbus consists of thickened connective tissue and is firmly attached to the osseous spiral lamina on which it rests.The spiral limbus provides support for tectorial and basilar membranes.

Organ of Corti :

Attached to the upper surface of basilar membrane extending into the scala media is a highly specialized portion of the cochlear duct, the organ of corti. It consists of two types of cells, sensory cells which transduce sound energy into general activity and supporting cells which provide support to organ of corti. The afferent fibres of auditory nerve and efferent fibres of the

olivocochlear bundle enter the organ of corti from underneath the basilar membrane and innervate the sensory cells.

The sensory cells consists of inner and outer hair cells, so named because of the sensory hair (Stereocilia) that extends from the upper surface and their relative proximity to the modiolus. There are about 34000 inner hair cells and 12000 outer hair cells. The inner hair cells are flask shaped. Its upper surface is covered with thick, rigid cuticle from which 3 to 4 straight or slightly curved parallel rows of stereocilia project. Actin filaments extends from surface to base of each hair ensuring it with rigidity and shape. The outer hair cells are cylindrical. Like the inner hair cells they have a cuticular plate, a small cuticle free surface with underlying basal body, and stereocilia which are arranged in rows according to height. The sterocilia of outer hair cells form 6 to 7 parallel rows in the shape of V or W.

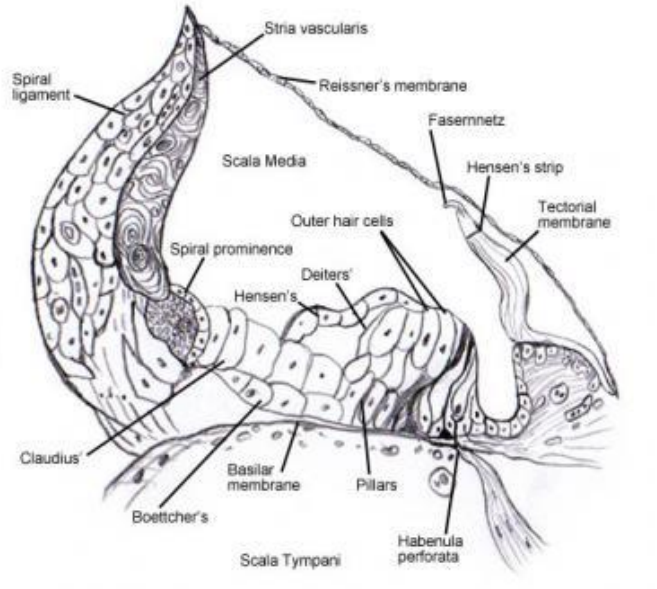


Figure -3: organ of corti

The hair cells are supported in a rigid frame work of what is collectively called supporting cells. As one moves from the spiral limbus towards the spiral ligament, the supporting cells include the inner border cells, the inner pharyngeal cells, Hensen's cells,Claudius cells, and the outer sulcus cells. The main structural support is provided by pillar cells and Dieter's cells.

There are number of fluid filled spaces enclosed within the organ of corti. This includes tunnel of corti between the pillar cells, Nuel space between the outer pillar cells and the first row of inner hair cells, the outer tunnel between the outer row of outer hair cells and inner row of Hensen's cells and spaces that separate the outer hair cells. These spaces are filled with Cortilymph.

Suspended above the organ of corti and connected to interdental cells of spiral limbus, is the tectorial membrane, which is completely acellular. It consists of transversely running filaments and has a gelatinous consistency.

Innervation of the Cochlea:

Cochlea is connected with brain stem by afferent and efferent nerves.

Afferent Innervation :

The auditory portion of VIII nerve provides the afferent innervation of the inner and outer hair cells. The cell bodies of cochlear nerve are located in the modiolus within the Rosenthal's canal. Here they form spiral ganglion.

The axon of each ganglion cell extends centrally through longitudinal modular canal upto the cerebello pontine cistern synapse in the cochlear nucleus. The peripheral process ends as dendrite beneath the hair cells.

Efferent Innervation :

It is provided by olivocochlear bundle. The cell bodies of olivocochlear bundle are located in the brain stem within the superior olivary complex. The olivocochlear bundle is divided into medial and lateral components.

The medial division of olivocochlear bundle consists of myelinated fibres that originate from large cells in the medial part of superior olivary complex. Axons from superior olivary complex cross over to the other side of the brain just below the floor of the fourth ventricle and join the ipsilateral fibres. The ipsilateral and contralateral fibres travel peripherally within the vestibular nerve and join the cochlear nerve through corti's anastamosis just distal to the sacuolar ganglion.

The lateral division of olivocochlear bundle consist of unmyelinated fibres which originate in small cell in lateral portion of superior olivary nucleus. These fibres follow the same course as does the medial division into organ of corti.

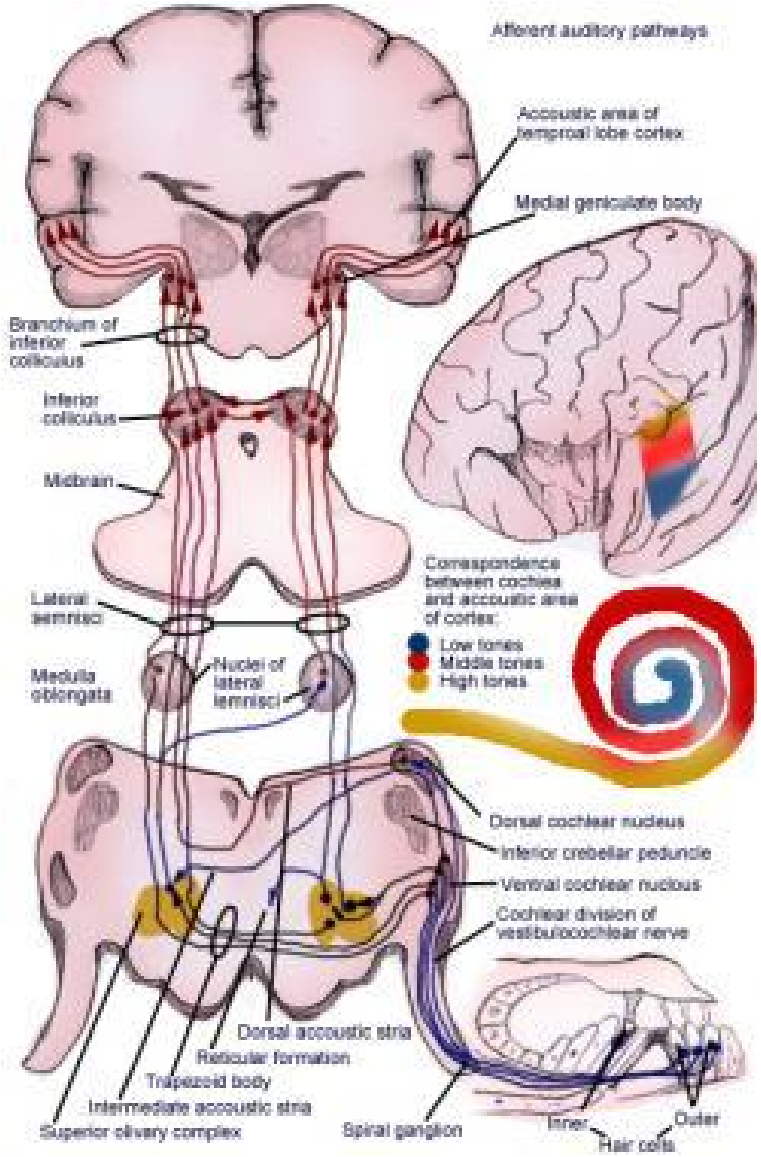


figure -4: Auditory pathway.

Vascular Supply :

The arterial supply to the cochlea is from two arteries that branch from common cochlear artery. These are

i) Main cochlear which supplies the modiolous particularly at upper basal, middle and apical coils.

ii) Cochlear ramus of the vestibulocochlear artery, which supplies 1/4th of the basilar coil and modilous. Once within the modiolus the arteries branch to form an external and internal radiating arterioles. The external one travels within the interscalar septum to the lateral wall of the coil. The internal radiating arteriole supplies the medial wall of the coil and organ of corti.

The venous drainage of inner ear is through the veins of vestibular and cochlear aqueducts. The primary drainage of cochlea is by anterior and posterior spiral veins. The posterior vein drains the inferomedial aspect of cochlea mainly spiral ganglion, scala media and scala tympani. The anterior spiral vein drains the superolateral aspect mainly scala vestibuli and osseous spiral lamina. These veins enter the common modiolar vein which enters the vein of cochlear aqueduct, tributary of inferior petrosal sinus.

Physiology :

There are two essential physiological process in cochlea namely transmission and transduction. Transmission is the transfer of acoustic energy from oval window to hair cells. While transduction is the conversion of sound energy pattern in organ of corti into action potential in the auditory nerve. [36.]

Electrical Potentials Cochlea :

Two main types of potentials have been identified the steady or resting potential and the superimposed QC voltage fluctuations due to acoustic stimulation.

The resting potential in scala media is +80mv known as endolymphatic potential and hair cell has –80mv, So that there is potential difference of 160mv between scala media and interior of hair cells.

The cochlear microphonics is the main component and confers upon the cochlear potentials. It has two elements cochlear microphonics 1, which is oxygen dependent and cochlear microphonics 2, which is oxygen independent. Cochlear microphonics is generated at the hair cell tectorial membrane area by piezo electrical effect due to deformation by sound vibration of the hair or hair cell bodies.

Cochlear Hydrodynamics :

There is basic assumption underlying present day theories of hearing that cochlear fluids vibrate from window to window. These are called travelling waves. This wave appears at basal end of basilar membrane and moves until maximum is reached. Beyond this the amplitude falls rapidly and there is alteration in the phase of vibrations. The form of wave is independent of frequency but the region of maximum displacement of the basilar

membrane varies according to the frequency. High pitched sounds cause a short traveling wave, which does not extend beyond the basal turn.

Middle and low frequencies produce the maximum displacement progressively nearer the apex as the frequency is lowered.

Theories of Hearing :

Helmholtz suggested that frequency analysis by the ear was due to the fact that, each pitch would cause resonant vibration of its own, in particular place on the basilar membrane. It was postulated with some support from anatomical observation that the length, mass and tension of the combined basilar membrane and the organ of corti varied progressively from base to the apex of the cochlea so as to form a series of tuned resonators. In fact damping, not resonance is the more conspicuous property of this complex system.

Rutherford's telephone hypothesis is that the basilar membrane vibrates uniformly in all its parts and that its amplitude represents the intensity of signal. Meanwhile he postulated that the frequency of signal is represented by the rate of firing of the auditory nerve fibres. This hypothesis simplifies the complexity of the nerve to a mere piece of wire and relegates to the CNS all problems relating to frequency analysis. Such a view has never been acceptable in the light of what is known as neurophysiology. The refractory period of nerve action would itself limit the upper frequency of the system to less than 1000 Hz.

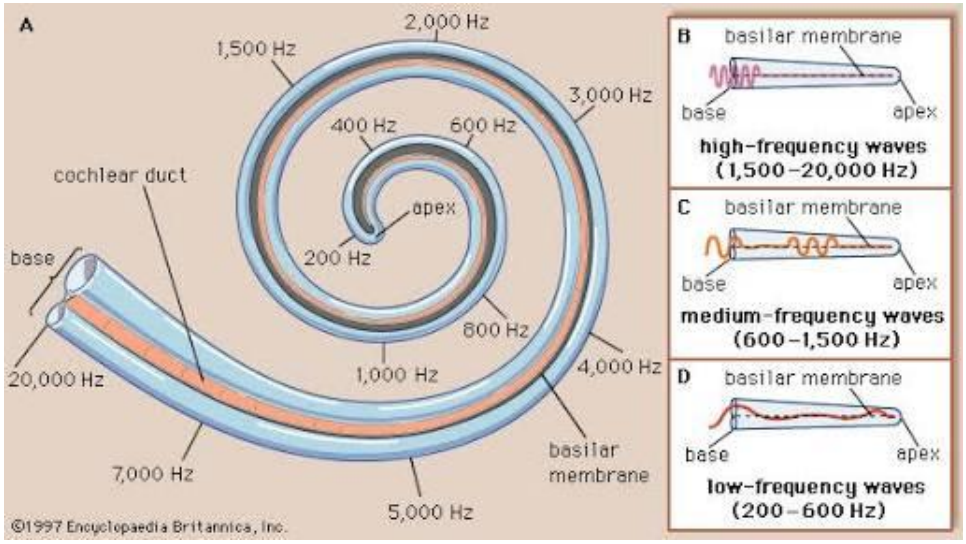


Figure-5: representing different frequencies in cochlea.

Weaver put forward "volley theory" which meets many of the requirements. It states that high frequency perception is due to stimulation of hair cells in basal turn only low frequency stimulate entire organ of corti and are represented in auditory nerve by nerve fibre responses which are directly synchronous with applied signal wave from.

Between 400 and 5000Hz, groups of fibres fire asynchronously so that despite the limitations of the frequency of the signal is represented to the CNS by sequential firing the pairs, trios or quarters of fibres. There is presumed to be a gradual transition from one mode of action potential to the next as signal frequency is raised or lowered.

Volley theory is supported by direct recording of action potentials in the auditory nerve and individual fibres.

PATHOGENESIS OF SENSORINEURAL HEARING LOSS IN DIABETICS :

The three main theories in the pathogenesis of sensorineural hearing loss in diabetic patients are microangiopathy of cochlear vessels, neuropathy of auditory nerve and alteration in inner ear glucose levels.

The angiopathy of the inner ear leads to deafness either by diminution of transport of nutrients through thickened capillary walls or by diminution of blood flow through narrowed vasculature. The primary diabetic neuropathy may be due to accumulation of sorbitol within the nervous tissue, the secondary neuropathy is due to decrease in the blood flow of vasa nervosum causing secondary degeneration of eighth cranial nerve. The inner ear utilizes glucose to produce energy and changes in the glucose concentration in the inner ear may alter hearing.

Recently it is been recognized that diabetics with mitochondrial DNA abnormalities are associated with sensorineural hearing loss. The pathogenesis being disruption of energy production which thus compromises tissues with high metabolic energy requirements like labyrinth of the ear.

Histopathological changes seen in inner ear in diabeties mellitus :

Microangiopathic changes with PAS positive precipitates in stria vascularis, internal auditory artery, modiolus, vasa nervosum of eighth nerve and spiral ligament.

There was also demonstration of hemorrhage in endolymph and perilymph along with loss of hair cells, atrophy of spiral ganglion, demyelination of eighth nerve and degenerative changes in brain stem and cerebellum.

RETINAL VASCULAR ANATOMY

The retina receives its nutrition from two discrete circulatory systems – the retinal blood vessels and the choroidal blood vessels both derived from the ophthalmic artery.[40,41] The inner two-thirds of the human retina is nourished by four branch of the central retinal artery each supplying a quadrant of retina. The temporal branches arch around the macula and create a foveal avascular zone which is a 0.4 mm diameter, capillary free zone of pure cone photoreceptors.[47,48]

Arteries and veins remain in the nerve fiber layer, while arterioles and venules extend into deeper layers of retina forming microvascular networks which vary from 3 layers at the posterior pole to one layer in the periphery Cilioretinal arteries, derived from posterior ciliary arteries, emanate from temporal rim of optic nerve head toward the macula. Because the only connection between retinal arterial and venous system is through the capillary network, no connection exist between the capillary beds derived from individual branch retinal arteries creating functional watershed zones. Retinal capillaries are 5-6 μm in diameter and consist of two layers – endothelial cells and a surrounding layer of pericytes. The pericyte to endothelial cell ratio is 1:1 which is relatively high compared with elsewhere in CNS. The tight junctions between the retinal capillary endothelial cells are the major component of inner blood retinal barrier. The retinal pericytes appear to be involved directly in the local control of retinal blood flow and may affect

endothelial cell proliferation. The branch retinal veins drain to central retinal vein.

The choroid is supplied posteriorly by 10-20 short posterior ciliary branches. Majority of them give rise to choriocapillaries containing fenestrated endothelium supplying the outer third of retina. The choriocapillaries are functionally divided into lobules. The outer choroid is mainly a venous system, with the choriocapillaries connecting with an intermediate layer and finally with exterior choroidal veins. An important portion of outer blood retinal barrier consists of choriocapillary basement membrane, Bruch's membrane and the intercellular junctions of the retinal pigment epithelium.[42]

Figure -6: Normal fundus photograph

Figure -7: Normal histology of retinal capillaries

PHYSIOLOGY

Compared to the choroidal circulation which is a high flow, variable rate system, the retinal circulation is a lower flow, constant rate system supplying a highly metabolically active tissue. The works of Riva (1981) and Robinson (1986)[43] showed that autoregulation maintains a constant retinal blood flow over a wide pressure range during ocular or systemic hypertension.

Autoregulation depends upon many constituents of microenvironment viz. endothelium, pericytes, smooth muscle cells, extracellular matrix and the soluble vasoactive molecules.

VASCULAR PATHOLOGY IN DIABETIC RETINOPATHY

1. Abnormal retinal haemodynamics correlate with abnormal visual function in diabetic retinopathy. Enlargement of FAZ correlates with degree of ischaemic maculopathy. In early stage of diabetes, capillary density and the size of FAZ correlate inversely with contrast sensitivity.

2. Total retinal blood flow is decreased in diabetics without diabetic retinopathy and increases as disease progresses prior to vasoproliferation.

3. There is significant retinal auto-regulatory dysfunction in proportion to disease.

MOLECULAR BASIS OF DIABETIC RETINOPATHY

The retinal changes in patients with diabetes result from five fundamental processes:

i. formation of retinal capillary micro aneurysms

ii.The development of excessive vascular permeability

iii. Vascular occlusion,

iv. The proliferation of new blood vessels and accompanying fibrous tissue on the surface of the retina and optic disc, and

v. The contraction of these fibrovascular proliferations and the vitreous.

The clinicopathological lesions of diabetic retinopathy have been well classified.

Although a multitude of pathogenic mechanisms have been proposed, the underlying dysfunctional biochemical and molecular pathways that lead to initiation and progression of DR still remains an enigma. Currently four major biochemical pathways have been hypothesized to explain the mechanism of diabetic eye diseases all starting initially from hyperglycaemia induced vascular injury.[49] These mainly include:

(i) Enhanced glucose flux through the polyol pathway

(*ii*) Increased intracellular formation of advanced glycation end-products (AGE)

(ii) Activation of protein kinase C (PKC) isoforms, and

(*iv*) Stimulation of hexosamine pathway

OPHTHALMOSCOPIC FEATURES OF DIABETIC RETINOPATHY[45]

Microaneurysms

Microaneurysms are localized out-pouchings, mainly saccular, of the capillary wall that may form either by focal dilatation of the capillary wall where pericytes are absent, or by fusion of two arms of a capillary loop. Most develop in the inner capillary plexus (inner nuclear layer) frequently in relation to areas of capillary non perfusion. Loss of pericytes may also lead to endothelial cell proliferation with the formation of 'cellular' microaneurysms. Microaneurysms may leak plasma constituents into the retina as a result of breakdown in the blood–retinal barrier, or become thrombosed.

Figure -8: microaneurysms of retinal capillaries

Retinal haemorrhages

1. Retinal nerve fibre layer haemorrhages arise from the larger superficial precapillary arterioles and are flame-shaped because of the architecture of the retinal nerve fibres

2. Intraretinal haemorrhages arise from the venous end of capillaries red 'dot/blot' shape, located in the compact middle layers of the retina.

3. Deeper dark round haemorrhages due to haemorrhagic retinal infarct located within the middle retinal layers.

Exudates

Exudates, sometimes termed 'hard' exudates to distinguish from the older term of 'soft' exudates for cotton wool spots, are caused by chronic localized retinal oedema developing at the junction of normal and oedematous retina. They are composed of lipoprotein and lipid-filled macrophages located mainly within the outer plexiform layer. Hyperlipidaemia is a risk factor for of exudate formation.

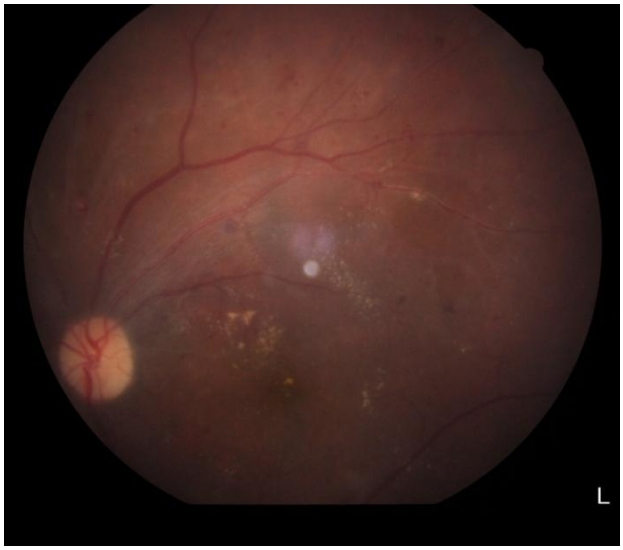


Figure -9: hard exudates.

Cotton wool spots

Cotton wool spots are composed of accumulations of neuronal debris within the nerve fibre layer, resulting from disruption of nerve axons. On light microscopy appear as globular structures in the nerve fibre layer .The swollen ends of which are known as cytoid bodies.

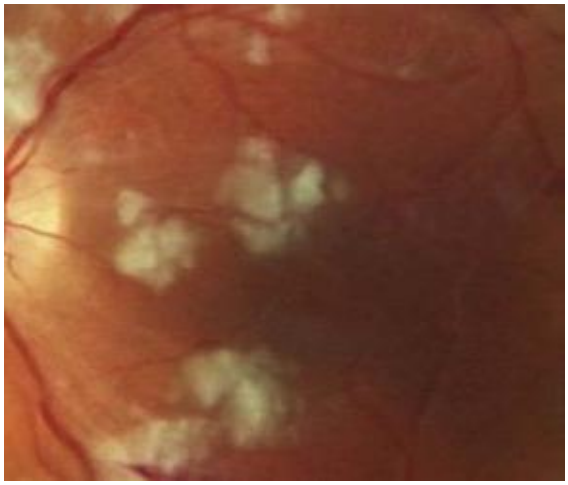


Figure -10: cotton wool spots.

Venous changes

Venous anomalies seen in ischaemia consist of generalized dilatation and tortuosity, ‘looping’, ‘beading’ and ‘sausage-like’ segmentation. The extent of the retinal area exhibiting venous changes is an important predictor for the likelihood of developing

proliferative disease.

Figure -11: venous dilatation.

Intraretinal microvascular abnormalities (IRMA) are arteriolar-venular shunts seen adjacent to areas of marked capillary hypoperfusion. They bypass the occluded capillary bed and run from retinal arterioles to venules.

Arterial changes: Subtle retinal arteriolar dilatation may be an early marker of ischaemic dysfunction. When significant ischaemia is present a variety of features are seen which include peripheral narrowing, silver-wiring and obliteration similar to the late appearance following a branch retinal artery occlusion.

Risk factors

- **Duration of diabetes** is the most important risk factor. In patients diagnosed with diabetes before the age of 30 years, the incidence of DR is 50% after 10 years, and after 30 years its about 90%. DR rarely develops within 5 years of the onset of diabetes or before puberty, but about 5% of type 2 diabetics have DR at presentation.

- **Poor control of diabetes.** It has been shown that tight blood glucose control, particularly when instituted early, can prevent or delay the onset & development or progression of DR. However, a sudden improvement in control may be associated with progression of retinopathy in the near term. Type 1 diabetic patients appear to obtain greater benefit from good control than type 2. Raised HbA1c is associated with an increased risk of proliferative disease.

- **Pregnancy** is sometimes associated with rapid progression of DR. Predicating factors include greater pre-pregnancy severity of retinopathy, poor pre-pregnancy control of diabetes, control exerted too rapidly during the early stages of pregnancy, and pre-eclampsia. The risk of progression is related to the severity of DR in the first trimester. If substantial DR is present, frequency of review should reflect individual risk, and can be up to monthly. Diabetic macular oedema usually resolves spontaneously after pregnancy and need not be treated if it develops in later pregnancy.

- **Hypertension**, which is very common in patients with type 2 diabetes, should be rigorously controlled (<140/80 mmHg). Tight control appears to be particularly beneficial in type 2 diabetics with maculopathy. Cardiovascular disease and previous stroke are also predictive.

- **Nephropathy**, if severe, is associated with worsening of DR. Conversely, treatment of renal disease (e.g. renal transplantation) may be associated with improvement of retinopathy and a better response to photocoagulation.

- **Other risk factors** include hyperlipidaemia, smoking, cataract surgery, obesity and anaemia.

Early Treatment Diabetic Retinopathy Study Group [ETDRS]:[53]

A) **Non-proliferative Diabetic Retinopathy [NPDR] :-**

1) **Minimal NPDR** :- Presence of microaneurysms only

2) **Mild NPDR**:- Microaneurysms + one or more of the following Intra-retinal haemorrhages, Hard exudates away from the macula, Cotton wool spots (CWS).

3**) Moderate NPDR** :- Microaneurysms / Hemorrhages in at least one quadrant+one or more of the following:-

Cotton wool spots, Intra-retinal microvascular abnormalities (IRMA)

Venous beading.

4) **Severe NPDR** :- Any one of the following (4-2-1 rule) Intra-retinal hemorrhages – severe, in 4 quadrants

Venous beading in 2 quadrants

Moderately severe intra-retinal microvascular abnormalities(IRMA) in 1 quadrant.

5**) Very severe NPDR** :- Any two of the following :-

Intra-retinal hemorrhages-severe, in 4 quadrants venous beading in 2 quadrants.

Moderately severe intra-retinal microvascular abnormalities in 1 quadrant.

B) **Proliferative Diabetic Retinopathy [PDR]** :-

1) **Early PDR** :- One or more of the following :-

NVD < ¼ disc diameter [DD]

NVE without hemorrhage

Pre-retinal or vitreous hemorrhage and NVE < ½ DD without hemorrhage.

2) **High risk PDR** :- One or more of the following :-

NVD >1/4 DD

NVD with hemorrhage.

NVE >1/2 DD with hemorrhage.

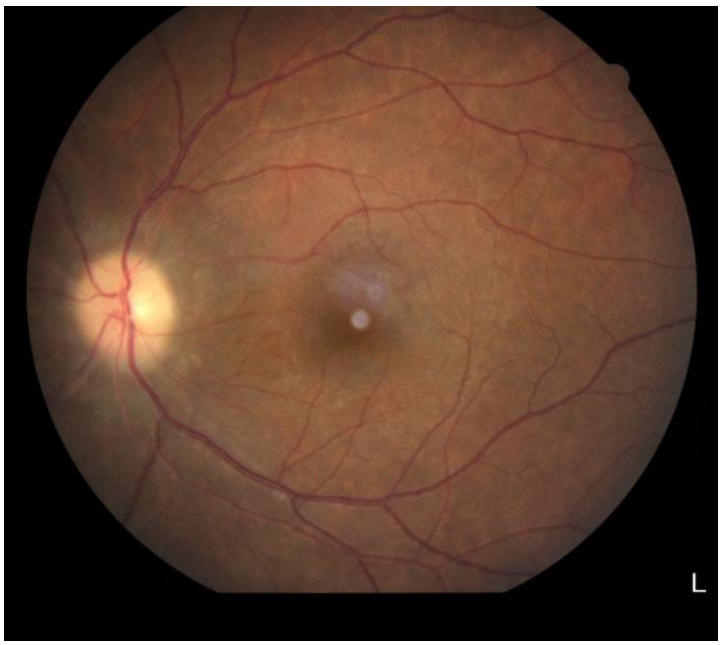


Figure -12: Mild NPDR.

Figure -13 a.: moderate NPDR.

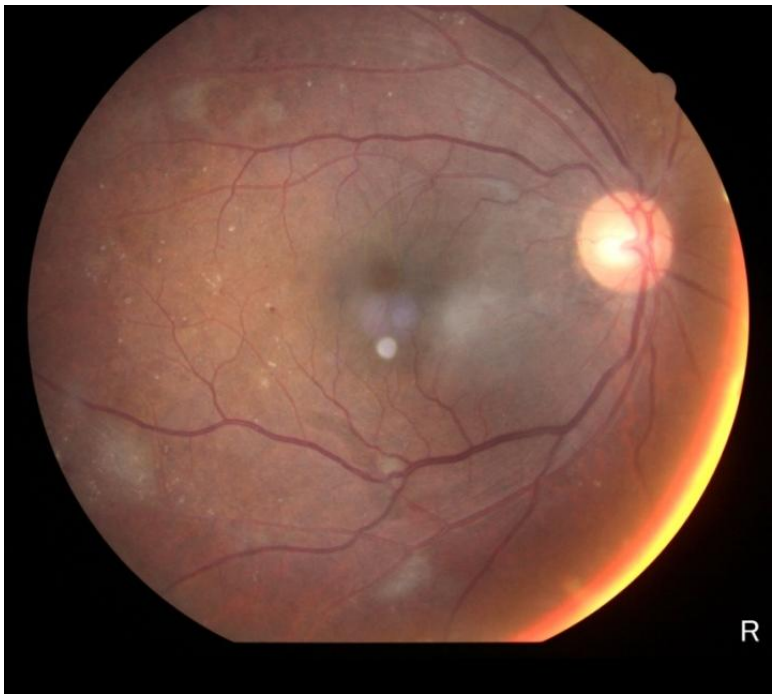


Figure -13 b.: moderate NPDR

Figure -14: severe NPDR

Figure -15: PDR

Clinically Significant Macular Edema (CSME)

As defined by the Early Treatment Diabetic Retinopathy Study (ETDRS) includes any one of these lesions.

1. Retinal thickening at or within 500 μm at the centre of the macula.

2. Hard exudates at or within 500 μm of the centre of the macula, if there is thickening of the adjacent retina.

3. An area or areas of retinal thickening at least one disc area in size, atleast a part of which is within 1 disc diameter of the centre of the macula.

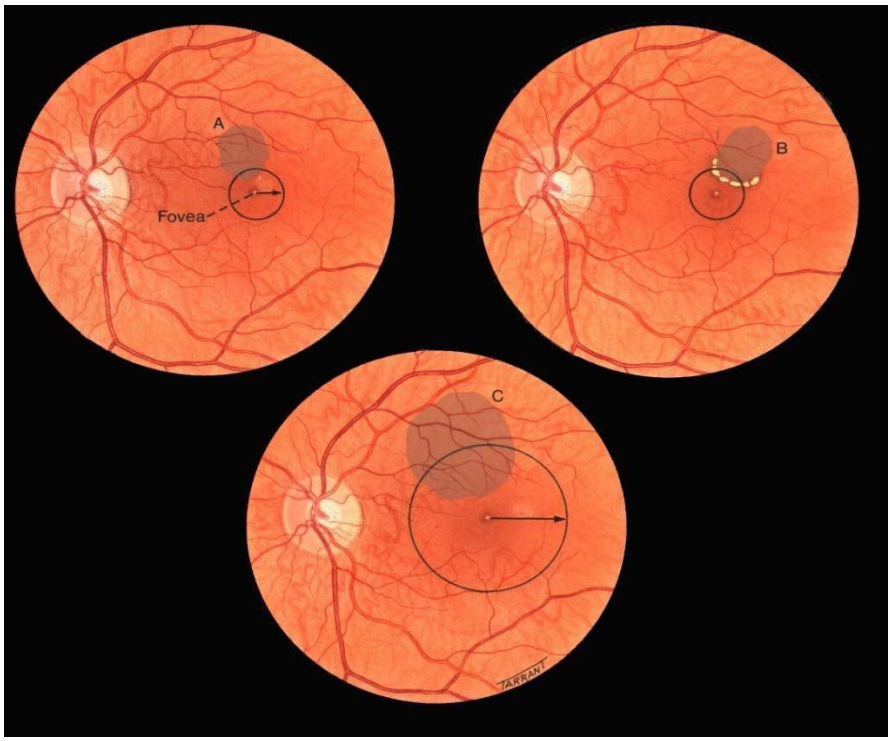


Figure -16: CSME.

Diabetic maculopathy is the most common cause of visual loss in nonproliferative diabetic retinopathy.

The various forms of diabetic maculopathy based on FFA include:

1. Focal exudative maculopathy: There is focal leakage with hard exudates, sparing the foveal center, and the prognosis is good.

2. Diffuse exudative maculopathy: There is diffuse macular oedema and the prognosis is often poor.

3. Ischaemic maculopathy: There are extensive areas of macular nonperfusion, soft exudates and large deep retinal hemorrhages with retinal thickening seen on ophthalmoscopy. There is reduced visual acuity with a relatively normal appearance of the fovea.

4. Mixed maculopathy: characterized by features of both ischaemia and exudation.

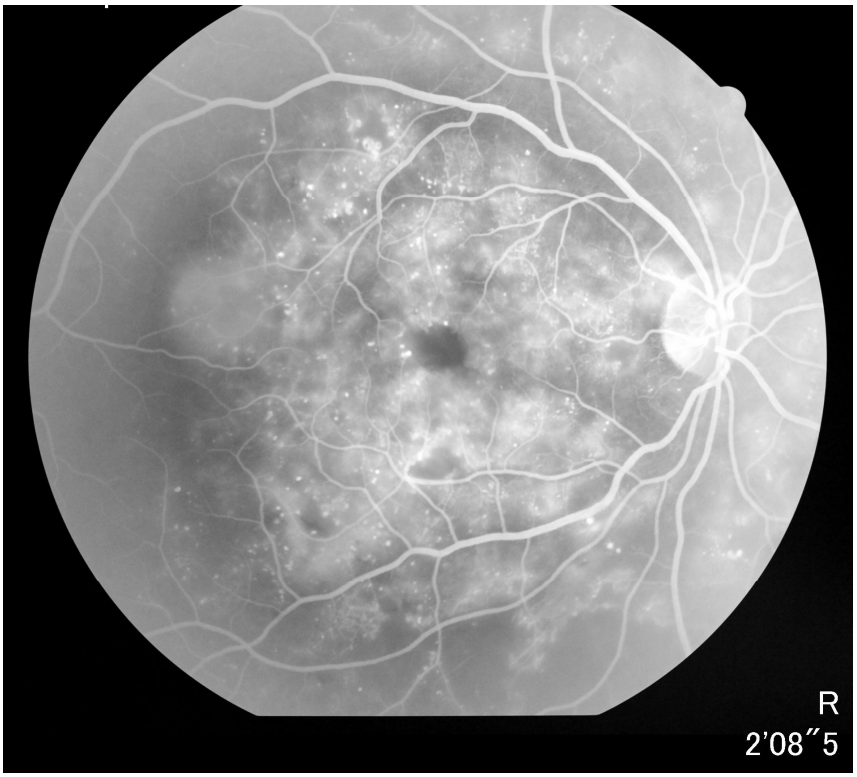


Figure -17: fundus fluorescein angiograph with macular edema.

MATERIAL & METHOD

METHOD:

A sample of 92 subjects are selected by blind randomization & divided into cases & controls of 46 individuals in each. Detailed clinical examination of ear & eye is performed, including tuning fork tests fundoscopy & subjected to investigations. The data collected from these tests & investigations are subjected to appropriate statistical tests to arrive suitable conclusions.

SAMPLE SIZE:

- The sample size was determined by using G*Power software 3.1 Version with a power of 95 % and confidence interval level 95 %.
- The estimated sample size was 42 in each group.
- Considering the attrition rate 10 %, a total of 46 samples in each group was planned for the study.

MATERIAL:

CASES: - A sample of 46 patients of diabetes mellitus of both sexes, selected based on following inclusion criteria.

CONTROLS: - a sample of 46 non-diabetic subjects of both sexes, selected based on following inclusion criteria.

INCLUSION CRITERIA FOR CASES:

1. Age 18-55.
2. Known diabetic patients attending diabetology clinic.
3. Patients with no history of ototoxic drug consumption in past.
4. Subjects with no history of any ear disease or ear surgeries in past.
5. Patients without noise induced hearing loss as per PTA. (dip at 4000Hz).
6. Diabetic patients without any pre existing co-morbidities which are likely to affect hearing. (hyperlipidemia, hypertension)
7. Diabetic patients without pre existing retinopathy.

INCLUSION CRITERIA FOR CONTROLS:

1. Age 18-55
2. Normoglycemic.
3. Subjects with no history of ototoxic drug consumption in past.
4. Subjects with no history of any ear disease or ear surgeries in past.
5. Subjects without noise induced hearing loss.
6. Normal individuals without any pre existing co-morbidities which are likely to affect hearing. (hyperlipidemia, hypertension)
7. Normal individuals without pre existing retinopathy.

EXCLUSION CRITERIA:

1. Age <18 & >55.
2. H/o prolonged exposure to noise (e.g. Industrial workers).
3. H/o ear discharge, perforated tympanic membrane or any chronic ear disease & ear surgeries in the past.
4. H/o intake of ototoxic drugs intake.
5. H/o pre existing co-morbidities which are likely to affect hearing.

STATISTICAL TOOLS:

- The collected data was analysed with SPSS 16.0 version.
- To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and for continuous variables the mean and S.D will used.
- To find the significance difference between the Independent groups (Cases & Controls) Unpaired t-test will be used.
- For age wise comparison One way ANOVA will be used.
- To assess the relationship between the variables Pearson's Correlation will be used.
- To find the significance in the categorical data Chi-Square test will be used.
- In all the above statistical tools the P value $\leq .05$ is considered as significant level.

PROCEDURE:

- **PURE TONE AUDIOMETRY (PTA)**

  The patient should be visible to the tester and respond by raising his finger after hearing stimulus. No visible or tactile clues should be given to patient which may suggest the presentation of auditory stimulus. The test should be performed in sound proof room.

The duration of presentation of stimulus should be 1-3 seconds. Rhythmic presentations should be avoided which may lead to the patients anticipating near threshold levels and likewise regular automatic switching should not be used. Unduly long interval between thresholds may lead to poor measured thresholds. Initially patient is familiarized to the sound by presenting a tone above the clinical hearing level and checking that the patient indicates whole duration of stimulus by changing the length of stimulus.

The threshold of hearing for a pure tone is the maximum tone that can elicit a response from at least 50% of the individual presentations. The test starts with better ear in the following order: 1KHz, 2KHz, 4KHz, 8KHz, 500Hz and 250Hz. If there is difference in the air conduction threshold exceeding 40dB at any frequency, masking should be used.

Bone conduction threshold are obtained similarly, as for air conduction but sound stimulus is given by bone vibrator placed on mastoid process. Care

is taken to remove intervening hair. Measurements are restricted to frequencies up to 4000Hz only.

Air conduction thresholds in the right and left ears were marked by ‘O’ and ‘X’ respectively. Bone conduction threshold is obtained by using bone vibrator placed on the skin over mastoid process and assessed to a maxium of 4000Hz.

It is represented by symbols ‘[‘ and ‘]’ for right and left ear respectively. Masking is employed when the difference in right and left unmasked air conduction threshold is 40dB or more.

The hearing threshold grading is given by:

1. 0-25dB –normal hearing
2. 26-40 dB –mild hearing loss
3. 41-55dB –moderate hearing loss
4. 56-70dB –moderately severe hearing loss
5. 71-90dB-severe hearing loss
6. >90dB- profound hearing loss

FUNDOSCOPY:

Fundoscopy consists exclusively of inspection. One looks through the *ophthalmoscope*, which is simply a light with various optical modifications, including lenses. The ophthalmoscope illuminates the retina through the normal iris defect that is the pupil. Light rays forming the image of the retina re-emerge through the pupil. The viewing aperture (window) of the ophthalmoscope contains a lens that modifies light rays to assist the user. In the procedure, one looks at structures lying in the innermost aspect of the globe, collectively known as the *eyegrounds:* retina, retinal blood vessels, optic nerve head (disc), and to a limited degree, subjacent choroid. The pupil is frequently dilated pharmacologically to render retinal inspection easier, and for examination of the macula. One paralyzes the pupilloconstrictor muscle of the iris with nonabsorbable, short-acting topical *parasympatholytic drugs,* resulting in a larger pupillary aperture.

VISION TEST:

The goal in testing central visual acuity is to determine the best possible visual acuity in each eye. In most instances, either a standard printed Snellen eye chart is used with the patient 20 feet (6 m) away or a reading card with a reduced eye chart is used at 14 inches (35 cm). One eye at a time is tested with the fellow eye occluded. If distance spectacles are used by the patient (i.e., "the glasses you drive and walk around with"), they should be worn during

testing. If the reduced visual acuity card is being used at 14 inches, the patient over 40 years of age should wear reading glasses or bifocals ("the glasses you read with"). Should the patient's glasses not be available, an approximation of best corrected visual acuity can be obtained with the use of a pinhole held as close to the eye as possible while testing vision. A much easier and faster technique is to instruct the patient to "read the smallest line that you can see." Often, this will result in the patient going right to the 20/20 line and reading it correctly.

Blood investigations:

The patient's blood was assigned for the routine blood investigations as haemoglobin, total count, differential count and platelets to rule out anaemia, leukaemia and other disorders. Fasting and post prandial blood sugar levels were measured in the central laboratory attached to our hospital. To assess the diabetic control of the patient in the last 3 months HbA1c was done and graded as:

- < 7% -good control
- 7-8%- moderate control
- >8%- poor control

The renal parameters like blood urea (25-45mg/dl) and serum creatinine (0.7-1.5mg/dl) were also taken in to account. Routine urine analysis was done to monitor microalbuminuria and ketone bodies.

In our study the cut off values for cases and controls were as follows:

1) HbA1C levels between 4.5 and 5.7% (for controls only)

2) Total serum cholesterol ≤ 200 mg/dl

3) LDL ≤ 130 mg/dl

4) HDL ≤ 55 mg/dl for males and between 45 and 65 mg/dl for females

5) Triglycerides ≤ 160 mg/dl

6) Creatinine: between 0.3 and 1.3 mg/dl

7) Proteinuria (measured in 24-hour urine volume) ≤ 0.15 g

8) High blood pressure was defined as systolic pressure > 140 mmHg and/or diastolic pressure >110 mmHg.

RESULT

The occurrences of sensory neural hearing loss and retinopathy among diabetic patients was compared with those of non-diabetics under the following parameters:

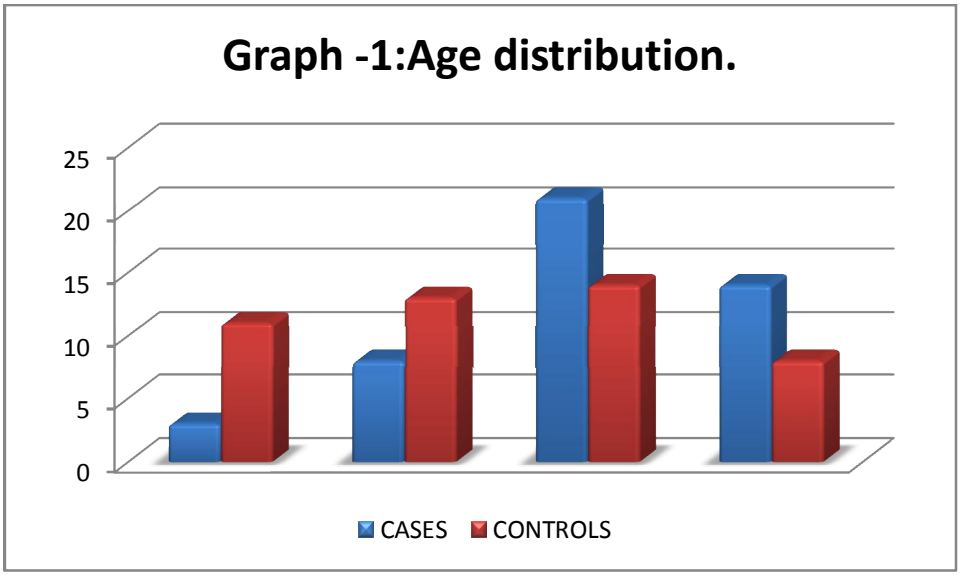
1. Age of individuals.
2. Sex of individuals.
3. Retinopathy among cases and controls.
4. SNHL among cases and controls.
5. Incidence of sensory neural hearing loss either sudden or gradual onset.
6. Vision acuity among cases and controls.
7. Retinopathy versus duration of disease.
8. SNHL versus duration of disease.
9. HbA1c versus SNHL.
10. HbA1c versus retinopathy.
11. Correlation between SNHL and retinopathy.

AGE DISTRIBUTION:

TABLE -1.

AGE DISTRIBUTION:

			CC		Total
			CASES	CONTROLS	
Age range	18- 30 yrs	Count	3	11	14
		% within CC	6.5%	23.9%	15.2%
	31 - 40 yrs	Count	8	13	21
		% within CC	17.4%	28.3%	22.8%
	41 - 50 yrs	Count	21	14	35
		% within CC	45.7%	30.4%	38.0%
	51- 55 yrs	Count	14	8	22
		% within CC	30.4%	17.4%	23.9%
Total		Count	46	46	92
		% within CC	100.0%	100.0%	100.0%



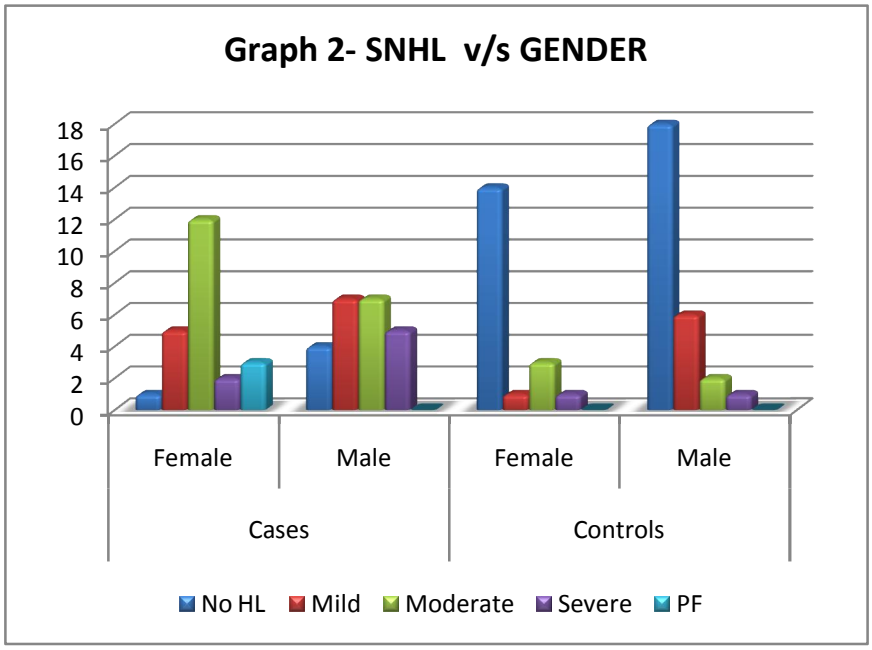
		N	Mean	Std. Deviation
AGE	CASES	46	45.22	7.922
	CONTROLS	46	39.78	10.035

Majority of cases that is 45.7% and 30.4% were in the age group of 41-50 years & 51- 55years respectively. Whereas controls were almost equally divided among different age groups. Mean of age distribution among cases is 45.22 years to that of controls its 39.78years.

SEX DISTRIBUTION:

TABLE -2: SNHL V/S GENDER AMONG CASES

SNHL V/S GENDER AMONG CASES			GENDER		Total
			Female	Male	
HEARINGLOSS	No HL	Count	1	4	5
		% within GENDER	4.3%	17.4%	10.9%
	Mild	Count	5	7	12
		% within GENDER	21.7%	30.4%	26.1%
	Moderate	Count	12	7	19
		% within GENDER	52.2%	30.4%	41.3%
	Severe	Count	2	5	7
		% within GENDER	8.7%	21.7%	15.2%
	PF	Count	3	0	3
		% within GENDER	13.0%	0.0%	6.5%
Total		Count	23	23	46
		% within GENDER	100.0%	100.0%	100.0%

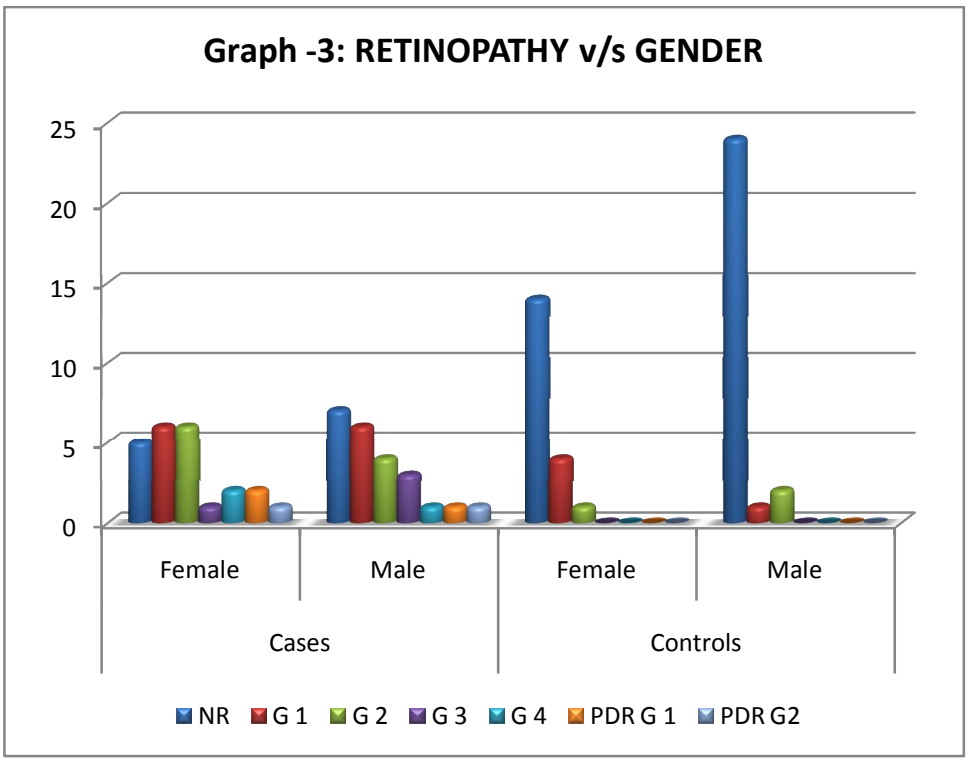


41.3% of cases with SNHL were men & 47.8% cases with SNHL were women.

There is no statistical significance between gender and SNHL with P value – 0.102.

TABLE-3: RETINOPATHY V/S GENDER AMONG CASES.

RETINOPATHY V/S GENDER IN CASES			GENDER		Total
			Female	Male	
RETINOPATHY	NR	Count	5	7	12
		% within GENDER	21.7%	30.4%	26.1%
	G 1	Count	6	6	12
		% within GENDER	26.1%	26.1%	26.1%
	G 2	Count	6	4	10
		% within GENDER	26.1%	17.4%	21.7%
	G 3	Count	1	3	4
		% within GENDER	4.3%	13.0%	8.7%
	G 4	Count	2	1	3
		% within GENDER	8.7%	4.3%	6.5%
	PDR G 1	Count	2	1	3
		% within GENDER	8.7%	4.3%	6.5%
	PDR G2	Count	1	1	2
		% within GENDER	4.3%	4.3%	4.3%
Total		Count	23	23	46
		% within GENDER	100.0%	100.0%	100.0%



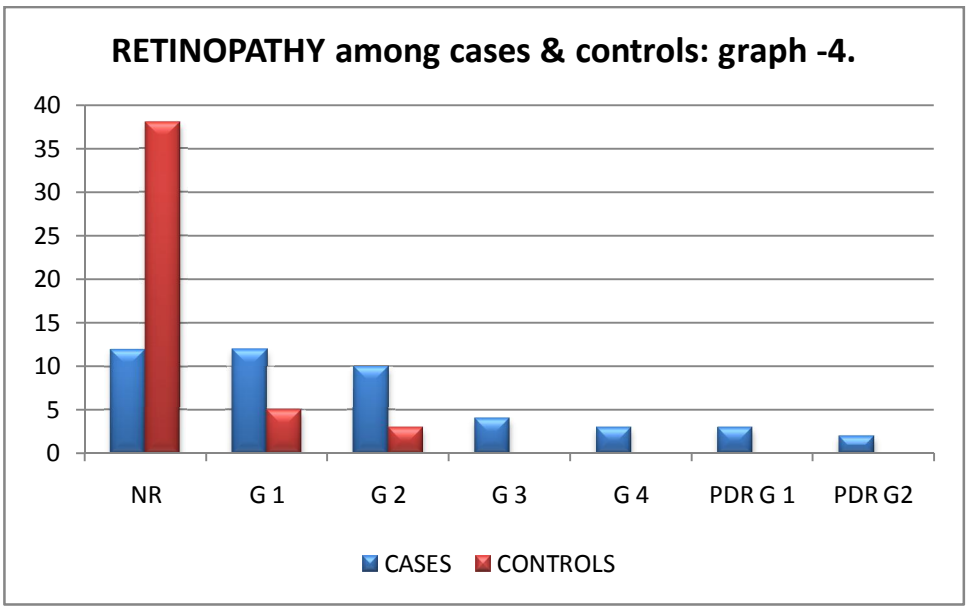
39.1% of cases with retinopathy were women & 34.78% of cases with retinopathy were men.

There is no statistical significance between gender and retinopathy with P value – 0.879.

RETINOPATHY AMONG CASES & CONTROLS:

TABLE -4.

			CC		Total
			CASES	CONTROLS	
RETINOPATHY	NR	Count	12	38	50
		% within CC	26.1%	82.6%	54.3%
	G 1	Count	12	5	17
		% within CC	26.1%	10.9%	18.5%
	G 2	Count	10	3	13
		% within CC	21.7%	6.5%	14.1%
	G 3	Count	4	0	4
		% within CC	8.7%	0.0%	4.3%
	G 4	Count	3	0	3
		% within CC	6.5%	0.0%	3.3%
	PDR G 1	Count	3	0	3
		% within CC	6.5%	0.0%	3.3%
	PDR G2	Count	2	0	2
		% within CC	4.3%	0.0%	2.2%
Total		Count	46	46	92
		% within CC	100.0%	100.0%	100.0%



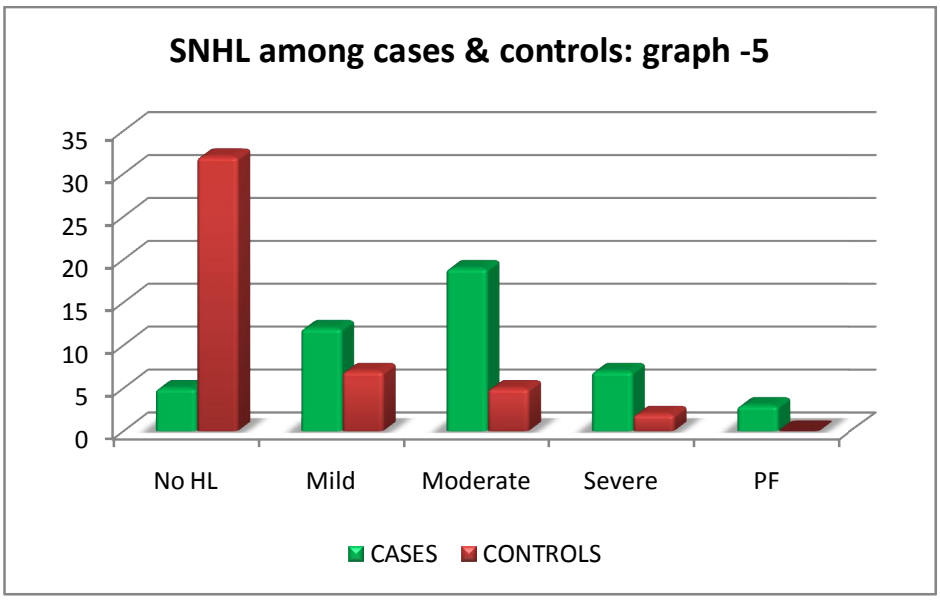
73.9% of cases had retinopathy when compared to controls only 17.4% of them had retinopathy.

Its statistically highly significant that cases are more prone for retinopathy than controls with **P value :- <0.001.**

Among 73.9% of cases with retinopathy 63% (29 cases) of them had NPDR & 10.8% (5 cases) of them had PDR.

SNHL AMONG CASES & CONTROLS: Table -5.

			CC		Total
			CASES	CONTROLS	
HEARINGLOSS	No HL	Count	5	32	37
		% within CC	10.9%	69.6%	40.2%
	Mild	Count	12	7	19
		% within CC	26.1%	15.2%	20.7%
	Moderate	Count	19	5	24
		% within CC	41.3%	10.9%	26.1%
	Severe	Count	7	2	9
		% within CC	15.2%	4.3%	9.8%
	PF	Count	3	0	3
		% within CC	6.5%	0.0%	3.3%
Total		Count	46	46	92
		% within CC	100.0%	100.0%	100.0%



89.1 % (41 cases) of cases had SNHL than compared to 30.4 % (14 controls) of controls who had SNHL.

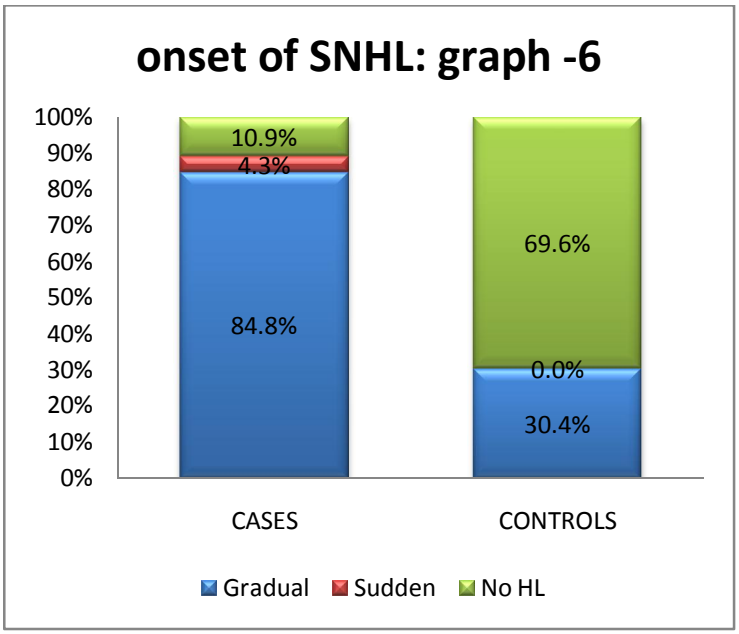
Its statistically highly significant that cases are more prone for SNHL than controls with **P value :- <0.001.**

INCIDENCE OF HEARING LOSS:

In our study of 46 cases, 41 cases had SNHL of which 2 had sudden SNHL. Among the 46 controls 14 of them had SNHL and none had sudden SNHL.

ONSET OF SNHL: TABLE -6

			CC		Total
			CASES	CONTROLS	
TYPE OF HL	Gradual	Count	39	14	53
		% within CC	84.8%	30.4%	57.6%
	Sudden	Count	2	0	2
		% within CC	4.3%	0.0%	2.2%
	No HL	Count	5	32	37
		% within CC	10.9%	69.6%	40.2%
Total		Count	46	46	92
		% within CC	100.0%	100.0%	100.0%



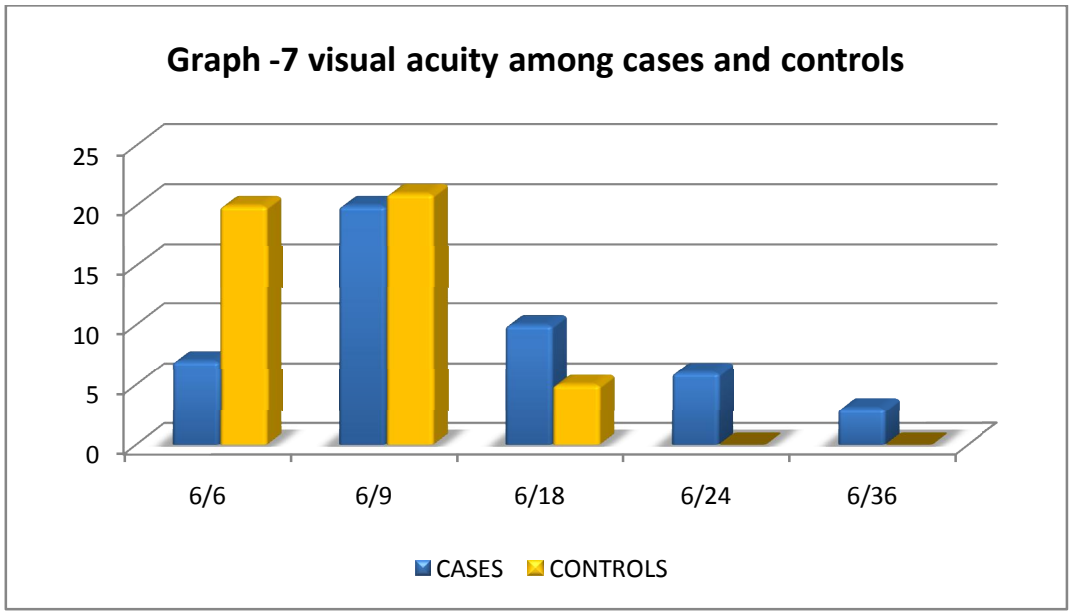
Incidence of SNHL was 89.1% (41 cases) among the cases, when compared to 30.4% among controls.

4.3% of cases had sudden onset SNHL and 84.8% had gradual SNHL.

VISUAL ACUITY AMONG CASES & CONTROLS:

TABLE -7

			CC		Total
			CASES	CONTROLS	
VISION TEST	6/18	Count	10	5	15
		% within CC	21.7%	10.9%	16.3%
	6/24	Count	6	0	6
		% within CC	13.0%	0.0%	6.5%
	6/36	Count	3	0	3
		% within CC	6.5%	0.0%	3.3%
	6/6	Count	7	20	27
		% within CC	15.2%	43.5%	29.3%
	6/9	Count	20	21	41
		% within CC	43.5%	45.7%	44.6%
Total		Count	46	46	92
		% within CC	100.0%	100.0%	100.0%



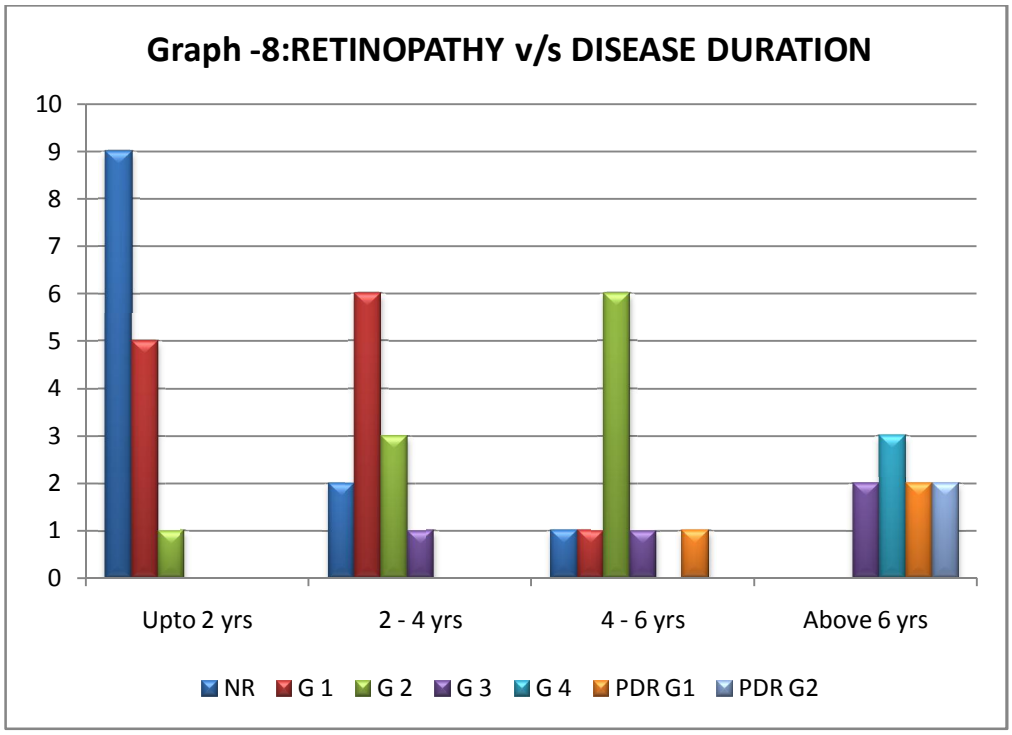
84.8 % (39 cases) of cases had vision acuity below 6/6 than compared to 56.5 % (26 controls) of controls who vision below normal.

It's statistically highly significant that cases are more prone for SNHL than controls with **P value :- <0.002.**

RETINOPATHY VERSUS DURATION OF DIABETES MELLITUS:

TABLE -8

			Duration of DM range				Total
			Upto 2 yrs	2 - 4 yrs	4 - 6 yrs	Above 6 yrs	
RETINOPATHY	NR	Count	9	2	1	0	112
		% within Drange	60.0%	16.7%	10.0%	0.0%	26.1%
	G 1	Count	5	6	1	0	12
		% within Drange	33.3%	50.0%	10.0%	0.0%	26.1%
	G 2	Count	1	3	6	0	10
		% within Drange	6.7%	25.0%	60.0%	0.0%	21.7%
	G 3	Count	0	1	1	2	4
		% within Drange	0.0%	8.3%	10.0%	22.2%	8.7%
	G 4	Count	0	0	0	3	3
		% within Drange	0.0%	0.0%	0.0%	33.3%	6.5%
	PDR G 1	Count	0	0	1	2	3
		% within Drange	0.0%	0.0%	10.0%	22.2%	6.5%
	PDR G2	Count	0	0	0	2	2
		% within Drange	0.0%	0.0%	0.0%	22.2%	4.3%
Total		Count	15	12	10	9	46
		% within Drange	100.0%	100.0%	100.0%	100.0%	100.0%



73.9 % (34 cases) of cases have retinopathy of varied severity.

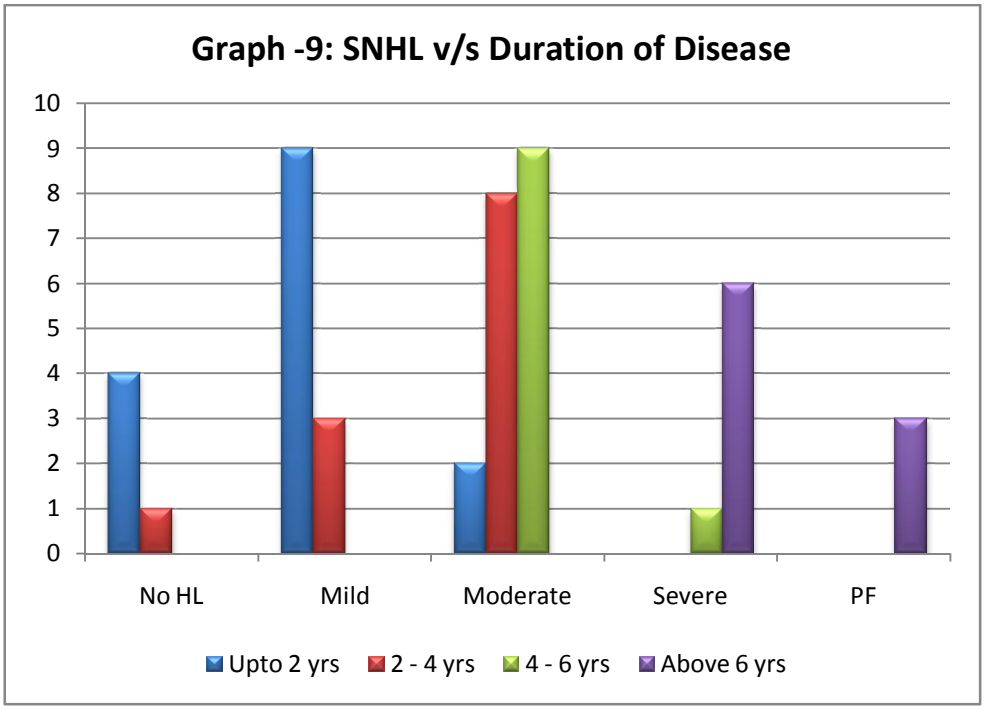
For all cases with duration of diabetes mellitus >2years 60.8% (28 cases) had retinopathy than compared to those having diabetes mellitus <2years only 13.0% (6 cases) of them had retinopathy.

4 of 5 cases with PDR had duration of diabetes mellitus >6years.

Its statistically highly significant that cases with longer duration of diabetes mellitus have more severe retinopathy with **P value:- <0.001.**

SNHL VERSUS DURATION OF DIABETES MELLITUS: table -9.

			Duration of DM range				Total
			Upto 2 yrs	2 - 4 yrs	4 - 6 yrs	Above 6 yrs	
HEARINGLOSS	No HL	Count	4	1	0	0	5
		% within Drange	26.7%	8.3%	0.0%	0.0%	10.9%
	Mild	Count	9	3	0	0	12
		% within Drange	60.0%	25.0%	0.0%	0.0%	26.1%
	Moderate	Count	2	8	9	0	19
		% within Drange	13.3%	66.7%	90.0%	0.0%	41.3%
	Severe	Count	0	0	1	6	7
		% within Drange	0.0%	0.0%	10.0%	66.7%	15.2%
	PF	Count	0	0	0	3	3
		% within Drange	0.0%	0.0%	0.0%	33.3%	6.5%
Total		Count	15	12	10	9	46
		% within Drange	100.0%	100.0%	100.0%	100.0%	100.0%



89.1% (41 cases) of cases have SNHL of varied severity.

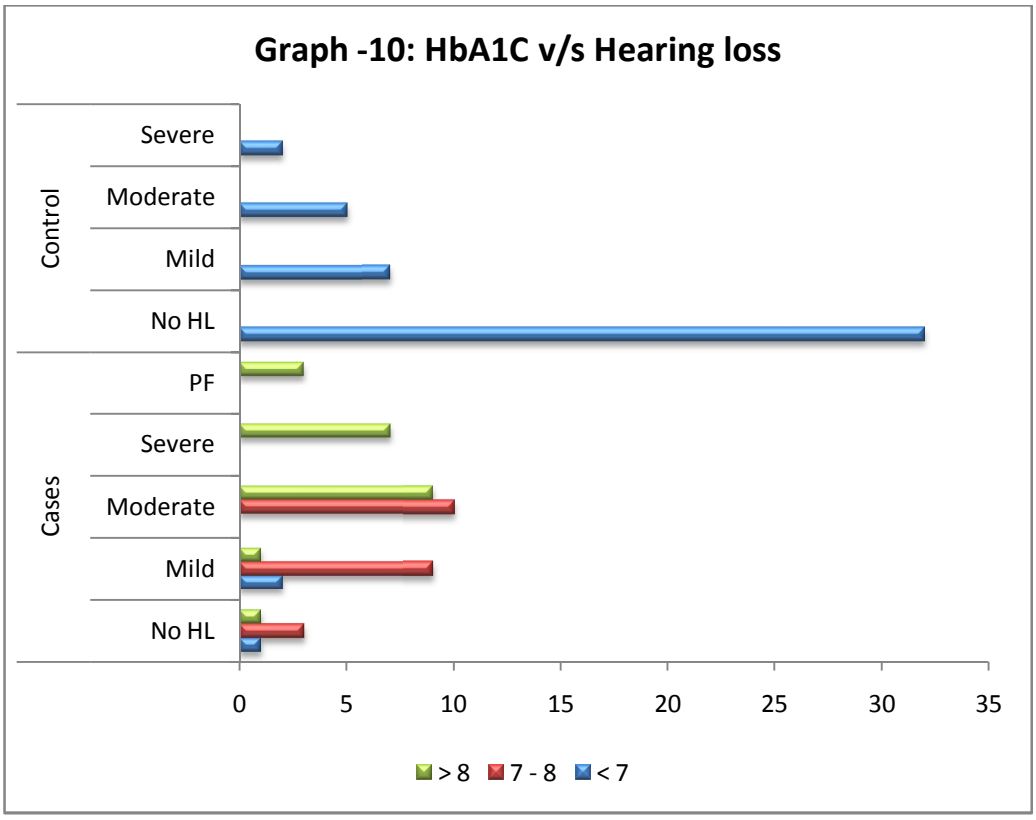
For all cases with duration of diabetes mellitus >2years 65.2% (30 cases) had SNHL than compared to those having diabetes mellitus <2years only 23.9% (11 cases) of them had SNHL.

Its statistically highly significant that cases with longer duration of diabetes mellitus have more severe SNHL with **P value: - <0.001.**

HbA1C VERSUS SNHL:

TABLE -10

CASES			HEARINGLOSS					Total
			No HL	Mild	Moderate	Severe	PF	
HBA1CRANGE	< 7	Count	1	2	0	0	0	3
		% within HEARING LOSS	20.0%	16.7%	0.0%	0.0%	0.0%	6.5%
	7 - 8	Count	3	9	10	0	0	22
		% within HEARING LOSS	60.0%	75.0%	52.6%	0.0%	0.0%	47.8%
	> 8	Count	1	1	9	7	3	21
		% within HEARING LOSS	20.0%	8.3%	47.4%	100.0 %	100.0 %	45.7%
Total		Count	5	12	19	7	3	46
		% within HEARING LOSS	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %



Among all the cases having HbA1C >7 about 84.7% (39 cases) of them had SNHL. Only 4.3% of cases having HbA1C <7 had SNHL & that too mild.

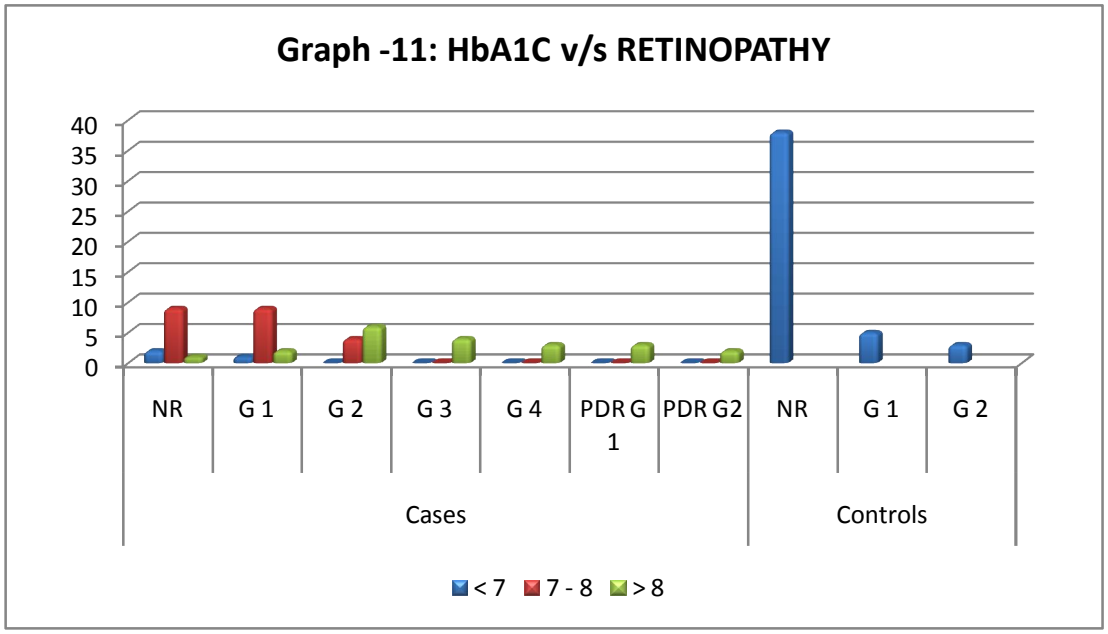
63 % (29 cases) of cases had SNHL >41 dB of which 41.35% (19 cases) of cases had HbA1C LEVELS >8.

Its statistically highly significant that cases with poor glycaemia control (higher HbA1C levels) have more severe SNHL with **P value: - <0.003.**

HbA1C VERSUS RETINOPATHY:

TABLE -11

			RETINOPATHY							
			NR	G 1	G 2	G 3	G 4	PDR G 1	PDR G2	Total
HBA1CRANGE	< 7	Count	2	1	0	0	0	0	0	3
		% within RETINOPATHY	16.7%	8.3%	0.0%	0.0%	0.0%	0.0%	0.0%	6.5%
	7 - 8	Count	9	9	4	0	0	0	0	22
		% within RETINOPATHY	75.0%	75.0%	40.0%	0.0%	0.0%	0.0%	0.0%	47.8%
	> 8	Count	1	2	6	4	3	3	2	21
		% within RETINOPATHY	8.3%	16.7%	60.0%	100.0%	100.0%	100.0%	100.0%	45.7%
Total		Count	12	12	10	4	3	3	2	46
		% within RETINOPATHY	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



Among all the cases having HbA1C >7 about 71.7% (33 cases) of them had retinopathy. Only 2.1% (1 case) of cases having HbA1C <7 had retinopathy & that too grade 1 NPDR.

45.7% (21 cases) cases having HbA1C >8 about 43.47% (20 cases) of them had retinopathy. 10.8% (5 cases) of cases had PDR & all of them had HbA1C >8.

Its statistically highly significant that cases with poor glycaemia control (higher HbA1C levels) have more severe retinopathy with **P value: - <0.008.**

CORRELATION BETWEEN SNHL AND RETINOPATY:

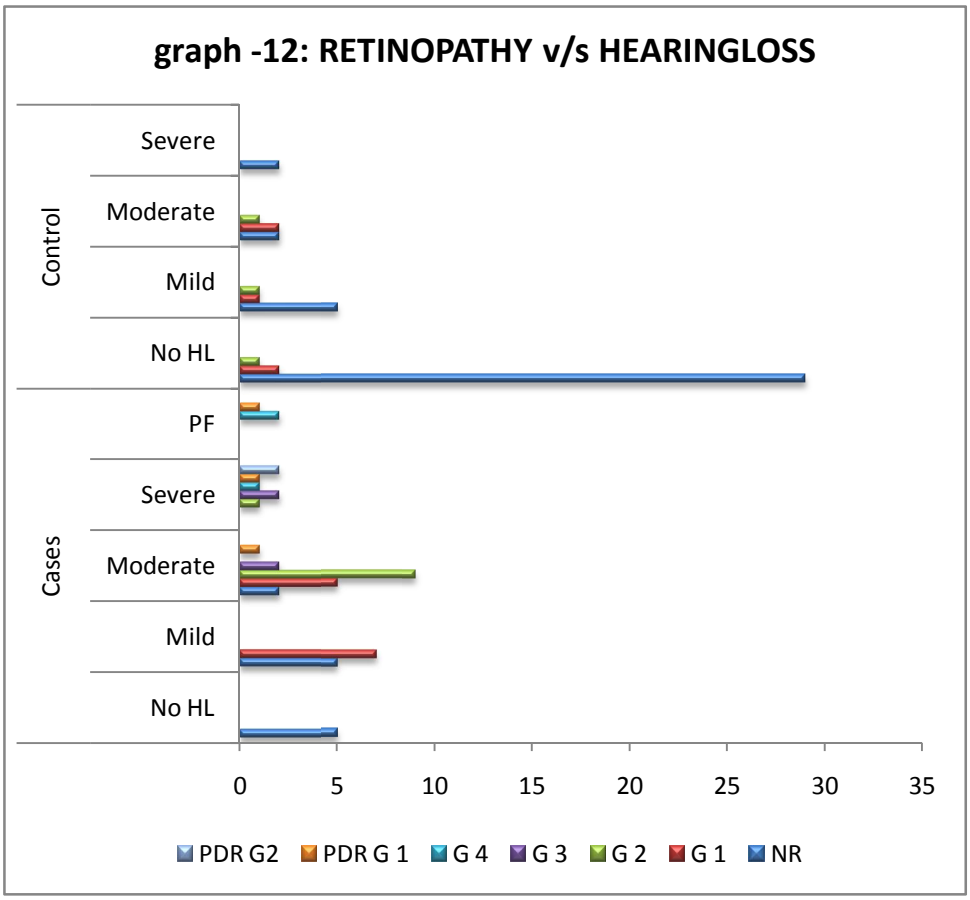
TABLE -12.

CASES			HEARINGLOSS					Total
			No HL	Mild	Moderate	Severe	PF	
*RETINOPATHY	NR	Count	5	5	2	0	0	12
		% within HEARINGLOSS	100.0%	41.7%	10.5%	0.0%	0.0%	26.1%
	G 1	Count	0	7	5	0	0	12
		% within HEARINGLOSS	0.0%	58.3%	26.3%	0.0%	0.0%	26.1%
	G 2	Count	0	0	9	1	0	10
		% within HEARINGLOSS	0.0%	0.0%	47.4%	14.3%	0.0%	21.7%
	G 3	Count	0	0	2	2	0	4
		% within HEARINGLOSS	0.0%	0.0%	10.5%	28.6%	0.0%	8.7%
	G 4	Count	0	0	0	1	2	3
		% within HEARINGLOSS	0.0%	0.0%	0.0%	14.3%	66.7%	6.5%
	PDR G 1	Count	0	0	1	1	1	3
		% within HEARINGLOSS	0.0%	0.0%	5.3%	14.3%	33.3%	6.5%

PDR G2	Count	0	0	0	2	0	2
	% within HEARINGLOSS	0.0%	0.0%	0.0%	28.6%	0.0%	4.3%
Total	Count	5	12	19	7	3	46
	% within HEARINGLOSS	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

47.8% (22 cases) of cases had SNHL >41dB (>/=moderate SNHL) and these same cases had retinopathy of grade 2 NPDR or higher severity of retinopathy.

Its statistically highly significant that diabetics (cases) with greater SNHL have more severe retinopathy with **P value: - <0.001.**



Unlike in cases there is no correlation between SNHL & retinopathy among controls.

DISCUSSION

The present study was conducted in Govt. Stanley medical college and hospital Chennai from 1st August 2014 to 31th July 2015(12 months). 46 cases of diabetes mellitus patients attending diabetology & ENT clinic were randomly selected according to inclusion criteria and 46 non-diabetics were randomly selected grouped as controls. These selected cases and controls were assessed for having sensorineural hearing loss and retinopathy.

Also they were assessed based on:

1. Age distribution.

2. Sex distribution.

3. Retinopathy, SNHL & vision acuity among cases and controls.

4. Incidence of disease.

4. Retinopathy & SNHL with respect to duration of disease.

5. Retinopathy and SNHL with respect to disease control.

6. Correlation between SNHL and retinopathy among diabetics.

AGE DISTRIBUTION:

Review of literature shows that there is no correlation between age of the patient and occurrences of SNHL and retinopathy among diabetics stated as per by Cullen-R[2] & Kurien-M[22].

Similarly no correlation was found in our study between age of the diabetics and its complications such as retinopathy and SNHL.

Mean age distribution among cases is 45.22 years to that of controls its 39.78years.

SEX DISTRIBUTION:

No studies till date have compared the hearing thresholds and retinopathy between diabetic men and women.

Our findings confirm with that of Nakaganvi et al.,[46] with no statistical significance between gender and disease.

41.3% of cases with SNHL were men & 47.8% cases with SNHL were women with P value – 0.102.

39.1% of cases with retinopathy were women & 34.78% of cases with retinopathy were men with P value – 0.879.

RELATIONSHIP BETWEEN RETINOPATHY, SNHL & VISION ACUITY AMONG CASES & CONTROL:

In our study 73.9% of cases had retinopathy when compared to 17.4% of controls with significant P value. 89% of cases had sensory neural hearing loss than that of 30.4% of SNHL among controls.

84.3% of cases had below normal visual acuity.

Confirming that diabetics are more prone for SNHL and retinopathy[7] with poor vision stated as per P A Wachyam[4], Gareth William, John C[5.]

INCIDENCE OF SENSORY NEURAL HEARING LOSS (SUDDEN OR GRADUAL):

Most of the recent literatures in recent times have supported the association of SNHL with DM.

In our study of 46 cases 89.1% of them had SNHL when compared to 30.4% among controls. 4.3% of cases had sudden onset SNHL and 84.8% had gradual SNHL. The results are similar to that of Friedman[18] and Aggarwal.[19]

Sensory neural hearing loss is usually gradual but Shuen Fu[54] in 2005 reported 68 cases of sudden SNHL.

DURATION OF DISEASE WITH THAT OF RETINOPATHY & SNHL:

Some studies state that the hearing threshold increases with increase in duration of DM[3,10] while some state that there is no relation between SNHL with duration.[22,2]

In our study 73.9% of cases had retinopathy. Among these 60.8% cases with >2years of DM had retinopathy. Only 13% of cases with <2years of DM had retinopathy.

About 39.1% cases of retinopathy had DM for >4 years. 4 out of 5 cases of PDR had DM > 6 years.

65.2% of cases with SNHL had DM > 2years while only 23.9% of cases with SNHL had DM <2 years. About 41.3% cases with SNHL had DM >4 years.

CONTROL OF DISEASE:

Occurrences of retinopathy and SNHL in diabetics depends upon the control of the disease. Most studies have stated that diabetic related complications such as retinopathy and SNHL can be prevented or delay their onset by controlling DM[22,2,4.]

Reduction in blood glucose or HbA1C concentrations through tight blood glucose control in diabetes reduces the rate of progression of retinopathy.

In our study cases with HbA1C >7 , 71.7% of them had retinopathy than compared to only 2.1% cases who had HbA1C <7.

43.47% of cases having retinopathy had HbA1C >8.

Similarly 84.7% of cases having SNHL had HbA1C >7. About 41.35% cases with SNHL had HbA1C >8.

CORRELATION BETWEEN SNHL AND RETINOPATHY AMONG CASES:

In our study 47.8% of cases had SNHL >41dB (>/=moderate SNHL) and these same cases had retinopathy of grade 2 NPDR or higher severity of retinopathy.

Its statistically highly significant that diabetics (cases) with greater SNHL have more severe retinopathy with **P value: - <0.001.**

SUMMARY

our study was aimed to determine the correlation between SNHL and Diabetic Retinopathy among diabetics.

92 participants were included in the study, who were divided into cases and controls with 46 in each group. In whom relevant history regarding their diabetes was noted i.e age at diagnosis of diabetes, duration of the diabetes, nature and duration of treatment received, glycemic control and compliance to the treatment. Patients were evaluated for their HbA1C levels, hypertension, lipid profile and renal parameters.

Each participant's diabetic retinopathy, SNHL and visual acuity status was classified accordingly.

In our study 73.9% of cases had diabetic retinopathy and 89% of cases had sensory neural hearing loss with significant P value.

60.8% cases with >2years of DM had retinopathy. About 39.1% cases of retinopathy had DM for >4 years. 4 out of 5 cases of PDR had DM > 6 years.

65.2% of cases with SNHL had DM > 2years of which 41.3% cases with SNHL had DM >4 years.

Cases with HbA1C >7 , 71.7% of them had retinopathy of which 43.47% of them had HbA1C >8. Similarly 84.7% of cases having SNHL had HbA1C >7 of which 41.35% had HbA1C >8.

47.8% of cases having SNHL >41dB (>/=moderate SNHL) had retinopathy of grade 2 NPDR or higher severity of retinopathy. Its highly significant that diabetics with greater SNHL have more severe retinopathy with **P value: - <0.001.**

Our study found a significant correlation between SNHL and diabetic retinopathy. The other factor which had a significant correlation was duration of diabetes with the severity of retinopathy and SNHL, glycemic control and the disease progression.

Other factors which did not have any significant correlation were Age of the patient, gender of the patient.

CONCLUSION

A statistically significant correlation was found between SNHL and the severity of diabetic retinopathy. More severe grades of SNHL and retinopathy manifesting in patients with higher levels of HbA1C and prolonged duration of DM.

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PROFORMA FOR REGISTRATION OF SUBJECTS FOR

DISSERTATION

NAME: **AGE/SEX:** **O.P/I.P**

No.

ADDRESS:

CHIEF COMPLAINTS:

DURATION OF ILLNESS:

HISTORY OF PRESENT ILLNESS:

PAST HISTORY:

TREATMENT HISTORY:

FAMILY HISTORY:

PERSONAL HISTORY:

GENERAL PHYSICAL EXAMINATION:-

PULSE: **BP:**

SYSTEMIC EXAMINATION:

CVS

RS

CNS

GIT

ENT EXAMINATION:

EAR: **LEFT** **RIGHT**

PRE & POST AURICULAR:

PINNA:

EAC:

TYMPANIC MEMBRANE:

TUNNING FORK TESTS

RINNE'S:

WEBER'S

ABC

NOSE:

ORAL CAVITY & OROPHARYNX:

OPHTHALMOLOGICAL EXAMINATION:

LEFT **RIGHT**

EYE LID:

CONJUCTIVA:

CORNEA:

PUPIL:

LENS:

SLIT LAMP:

OPHTHALMOSCOPY:

INVESTIGATIONS:

CBC

FBS

PPBS

HbA1C

FASTING LIPID PROFILE

URINE ANALYSIS

PTA

VISION TEST

FUNDOSCOPY

MASTER CHART

S.NO	NAME	IP NO	AGE	GENDER	DURATION OF DM	HBA1C	FBS	PPBS	HEARINGLOSS	TYPE OF SNHL	RETINOPATHY		VISION TEST	Antidiabetic drugs
i				MALE-1					NILL-0, MILD-1	GRADUAL-0	NPDR	PRD		INSULIN-1
ii				FEMALE-0					MODERATE-2	SUDDEN-1	GRADE-1	GRADE-1		ORAL HYPOGLY CEMIC-2
iii									MODERATELY SEVERE-3		GRADE-2	GRADE-2		BOTH-3
iv									SEVERE-4		GRADE-3			
v									PROFOUND-5		GRADE-4			
Cases														
1	damiyanthi	110051	52	0	7	12.7	204	320	3	0	3		6/18	2
2	sulochana	110257	48	0	5	7.4	158	284	2	0	2		6/9	2
3	shageela	110872	52	0	4	8.6	182	289	2	0	2		6/9	3
4	merryamal	110031	54	0	8	11.8	163	384	3	0	6	2	6/24	2
5	ezhil	110036	46	0	3	7.2	148	186	1	0	1		6/9	2
6	kazhimohi	110111	51	0	5	8.1	150	306	2	0	2		6/18	2
7	sabina begum	110171	40	0	2	7.7	146	259	2	0	1		6/9	2
8	kalavathi	110002	44	0	4	8.7	151	277	2	0	2		6/18	3
9	jayamaal	110099	42	0	1	7.1	140	176	1	0	0		6/6	2
10	poovamal	110078	50	0	5	9.2	198	229	2	0	5	1	6/36	3
11	abdulla	110055	42	1	0.5	8.3	155	194	1	0	1		6/9	2
12	rafeeq	101245	43	1	3	7.1	126	206	2	1	1		6/9	2
13	raman	110332	37	1	1	7.9	147	207	0	0	0		6/6	2
14	manohar	102036	39	1	2.5	7.7	123	191	1	0	1		6/9	2
15	krishna	105484	40	1	3	7	117	174	0	0	0		6/6	2

S.NO	NAME	IP NO	AGE	GENDER	DURATION OF DM	HBA1C	FBS	PPBS	HEARINGLOSS	TYPE OF SNHL	RETINOPATHY		VISION TEST	Antidiabetic drugs
16	devi	111025	52	0	9	12.94	281	412	4	0	4		6/24	2
17	manivannan	123546	54	1	6.5	9.9	190	340	3	0	5	1	6/24	3
18	suresh	102590	32	1	2	7.6	150	206	1	0	0		6/9	2
19	pista	111011	30	0	0.75	6.8	109	182	0	0	0		6/6	0
20	mohan	20148	46	1	3.5	7.1	138	240	1	0	1		6/9	2
21	david	301254	53	1	8	10.5	150	358	3	0	4		6/24	3
22	hasina	100213	48	0	4	8.6	144	278	2	0	1		6/9	2
23	ganesh	520321	28	1	5	7.5	135	190	2	0	2		6/18	2
24	murghan	548960	49	1	2	8	129	174	1	0	1		6/9	0
25	salman	456320	41	1	1	6.8	140	200	1	0	0		6/9	2
26	rameez	441203	19	1	1	8.9	240	388	0	0	0		6/6	1
27	sita	661044	50	0	5	7.2	146	209	2	0	1		6/18	2
28	kasiyammal	215814	54	0	10	12.2	200	398	4	0	4		6/36	2
29	aiysha	213587	43	0	2	7	170	249	1	0	1		6/9	2
30	suresh	236457	51	1	6	9	158	276	2	0	2		6/18	2
31	ramani	410256	50	0	5	7.8	145	214	2	0	2		6/18	2
32	munusamy	887925	45	1	2	6.7	119	220	1	0	1		6/9	2
33	babu khan	455628	53	1	7	11	209	418	3	0	3		6/18	2
34	kalaiselvi	94102	37	0	1.5	7.6	147	179	1	0	0		6/6	2
35	kamraj	456897	52	1	5	8.1	165	398	3	0	2		6/9	2
36	karthik	786546	33	1	0.75	7.7	133	255	0	0	0		6/6	2
37	sitalakshmi	103215	51	0	4	7.8	129	218	2	0	1		6/9	2
38	ayshamal	110101	44	0	3.5	8	130	291	2	0	0		6/9	2
39	saleema	561010	53	0	8	11.2	189	321	4	0	5	1	6/24	2
40	balu	223569	49	1	6	8.7	151	228	2	0	3		6/18	2
41	haneef	201230	50	1	5.5	8	141	203	2	1	0		6/9	3
42	shoaib	579425	49	1	4	8.87	122	320	2	0	3		6/24	2

S.NO	NAME	IP NO	AGE	GENDER	DURATION OF DM	HBA1C	FBS	PPBS	HEARINGLOSS	TYPE OF SNHL	RETINOPATHY		VISION TEST	Antidiabetic drugs
43	jayashree	113240	41	0	1	7.2	109	189	1	0	0		6/9	2
44	gayathri	789580	39	0	2	9	169	247	2	0	2		6/18	2
45	selvam	12569	54	1	9	9.9	153	289	3	0	6	2	6/36	2
46	prabhu	101578	50	1	3.75	8	143	199	2	0	2		6/9	2
Controls														
1	salman		24	1	0	5.4	89	132	0		0		6/6	
2	divya		28	0	0	4.46	92	140	0		0		6/6	
3	vasanthi		48	0	0	5.7	95	129	0		0		6/9	
4	kavitha		35	0	0	6	83	139	0		0		6/9	
5	ravikumari		54	0	0	5.2	77	138	2		1		6/18	
6	sultana		48	0	0	5.6	98	135	2		0		6/9	
7	kumar		50	1	0	5.5	80	128	1		0		6/9	
8	raghav		30	1	0	4.6	79	121	0		0		6/6	
9	rajshekher		52	1	0	5.12	88	128	1		2		6/18	
10	rosy		46	0	0	5.64	72	134	0		1		6/9	
11	shashikala		53	0	0	5.5	95	129	3		0		6/9	
12	ravi		32	1	0	5	82	122	0		0		6/6	
13	sathish		25	1	0	4.8	72	119	0		0		6/6	
14	krishnan		36	1	0	5.9	86	130	0		0		6/6	
15	kadhar khan		50	1	0	4.9	92	139	3		0		6/9	
16	mohanapriya		29	0	0	5.1	85	137	0		0		6/6	
17	lakshmi		44	0	0	4.23	88	130	0		1		6/9	
18	manohari		35	0	0	5	81	125	0		0		6/9	
19	mariyam		53	0	0	5.42	84	133	2		1		6/18	

S.NO	NAME	IP NO	AGE	GENDER	DURATION OF DM	HBA1C	FBS	PPBS	HEARINGLOSS	TYPE OF SNHL	RETINOPATHY		VISION TEST	Antidiabetic drugs
20	subhadra		40	0	0	5.17	97	122	1		0		6/9	
21	ganesh		52	1	0	5.6	89	137	1		0		6/9	
22	mahesh		39	1	0	5.2	70	122	0		0		6/9	
23	sukesh		20	1	0	4.6	87	128	0		0		6/6	
24	abdulla		41	1	0	5.4	99	131	0		0		6/9	
25	naveen		30	1	0	4.7	71	120	0		0		6/6	
26	shabri		49	1	0	5	88	125	0		0		6/9	
27	vellamal		41	0	0	5.69	98	131	0		0		6/9	
28	pachiyammal		50	0	0	5.54	100	136	0		2		6/18	
29	sabina		35	0	0	4.8	74	132	0		0		6/6	
30	shareef		42	1	0	5.7	94	121	0		0		6/6	
31	kasiyammal		45	0	0	5.31	99	125	0		0		6/9	
32	praveen		30	1	0	5	92	126	0		0		6/6	
33	suguna		31	0	0	5.7	100	139	0		0		6/6	
34	gopi		53	1	0	5.64	98	137	1		1		6/9	
35	soloman		52	1	0	4.68	92	139	2		0		6/9	
36	shabeer		49	1	0	5	90	121	0		0		6/9	
37	dhandapani		50	1	0	4.98	99	139	2		2		6/18	
38	saravanan		33	1	0	5.41	94	128	0		0		6/6	
39	rameez		32	1	0	5	87	135	1		0		6/6	
40	ashwini		24	0	0	4.8	69	122	0		0		6/6	
41	bindhu		34	0	0	5.5	77	133	0		0		6/6	
42	arun		39	1	0	5.29	99	134	0		0		6/6	
43	vivek		28	1	0	4.9	75	136	0		0		6/6	
44	murugeshan		54	1	0	5.16	80	110	1		0		6/9	
45	ajay		26	1	0	5	71	130	0		0		6/6	
46	shiva		39	1	0	5.4	96	133	0		0		6/9	

ETHICAL COMMITTEE APPROVAL LETTER:

INSTITUTIONAL ETHICAL COMMITTEE,
STANLEY MEDICAL COLLEGE, CHENNAI-1

Title of the Work : A study to correlate incidence & association of Sensorneural hearing loss & Retinopathy in patients with Diabets mellitus.

Principal Investigator : Dr. Santosh Kumar,

Designation : M.S.,(E N T)

Department : Department of E N T
Government Stanley Medical College,
Chennai-01

The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 26.11.2014 at the Council Hall, Stanley Medical College, Chennai-1 at 2PM

The members of the Committee, the secretary and the Chairman are pleased to approve the proposed work mentioned above, submitted by the principal investigator.

The Principal investigator and their team are directed to adhere to the guidelines given below:

1. You should inform the IEC in case of changes in study procedure, site investigator investigation or guide or any other changes.
2. You should not deviate from the area of the work for which you applied for ethical clearance.
3. You should inform the IEC immediately, in case of any adverse events or serious adverse reaction.
4. You should abide to the rules and regulation of the institution(s).
5. You should complete the work within the specified period and if any extension of time is required, you should apply for permission again and do the work.
6. You should submit the summary of the work to the ethical committee on completion of the work.

MEMBER SECRETARY,
IEC, SMC, CHENNAI

PATIENT INFORMATION SHEET

தகவல் படிவம்

தங்களுக்கு செய்த பரிசோதனைகள் மூலம் தங்களுக்கு சர்க்கரை நோய் உள்ளது என தெரியவந்துள்ளது. இதன் விளைவாக தங்களுக்கு கேட்கும் தன்மை மற்றும் பார்வை குறைப்பாடு ஏற்பட்டுள்ளது.

இந்த நோயைக் கண்டறிய பலவகை பரிசோதனை முறைகள் உள்ளன என்பதும் தங்களுக்கு PTA, FUNDOSCOPY, VISION TEST என்ற முறை பயன்படுத்தப்பட உள்ளது. இந்த சோதனை மூலம் கிடைக்கும் விளைவுகளை ஒப்பிட்டு ஆய்வு மேற்கொள்ளப்பட உள்ளது. இது குறித்த விவரங்களை ஆய்வில் பயன்படுத்த விரும்புகிறேன்.

தாங்கள் விரும்பினால் மருத்துவ ஆய்விலிருந்து எப்பொழுது வேண்டுமானாலும் விலகிக் கொள்ளலாம். எந்த சட்ட சிக்கலுக்கும் உட்படாமல் எப்பொழுது வேண்டுமானாலும் தாங்கள் ஆய்விலிருந்து விலகிக் கொள்ளலாம்.

இந்த ஆய்வின் மூலம் கிடைக்கும் தகவல்களும். பரிசோதனை முடிவுகளும் தங்களின் ஒப்புதலின் மூலம் மட்டும் ஆய்வில் பயன்படுத்தப்படும்.

ஆய்வாளரின் கையொப்பம் :

ஆய்வாளரின் பெயர் :

இடம் :

நாள் :

INFORMED CONSENT FORM

சுய ஒப்புதல் படிவம்

ஆராய்ச்சி நிலையம் : காது, மூக்கு, தொண்டை பிரிவு
அரசு ஸ்டான்லி மருத்துவக்கல்லூரி மருத்துவமனை

பங்கு பெறுபவரின் பெயர் :

பங்கு பெறுடவரின் எண் :

மருத்துவ பரிசோதனையின் விவரங்கள் எனக்கு விளக்கப்பட்டது. எனக்கு சர்க்கரை நோயினால் காது கேளாநிலை மற்றும் கண் குறைப்பாடு ஏற்பட்டுள்ளது என தெரியப்படுத்தப்பட்டது. எனது நோய் மற்றும் பரிசோதனை முறைகளை பற்றிய சந்தேகங்களை கேட்கவும் அதற்கான தகுந்த விளக்கங்களை பெறவும் வாய்பளிக்கப்பட்டது. இந்த நோயைக் கண்டறிய பலவகை பரிசோதனை முறைகள் உள்ளன என்பதும் எனக்கு PTA, FUNDOSCOPY, VISION TEST என்ற முறை பயன்படுத்தப்பட உள்ளது. இந்த சோதனை முறையின் விளைவுகளை ஆய்வில் பயன்படுத்த தன்னிச்சையாக சம்மதிக்கிறேன். எக்காரணத்தினாலும் எந்த கட்டத்திலும் எந்த சட்ட சிக்கலுக்கும் உட்படாமல் இவ்வாய்வில் இருந்து விலகி கொள்ளலாம் என்றும் அறிந்து கொண்டேன்.

இந்த பரிசோதனை மூலம் கிடைக்கும் தகவல்களையும் பரிசோதனை முடிகளையும் மருத்துவர் மேற்கொள்ளும் ஆய்வில் பயன்படுத்திக் கொள்ளவும் அதை பிரசுரிக்கவும் தேவைபட்டால் என்னையும் எனக்கு மேற்கொள்ளப்படும் பரிசோதனை முறைகளையும் புகைப்படம் எடுக்கவும் நான் முழு மனதுடன் சம்மதிக்கிறேன்.

பங்கேற்பவரின் கையொப்பம் நாள் :

இடம் :

கட்டைவிரல் ஒப்பம் :

பங்கேற்பவரின் பெயர் மற்றும் விலாசம்

நாள் :

ஆய்வாளரின் கையொப்பம்

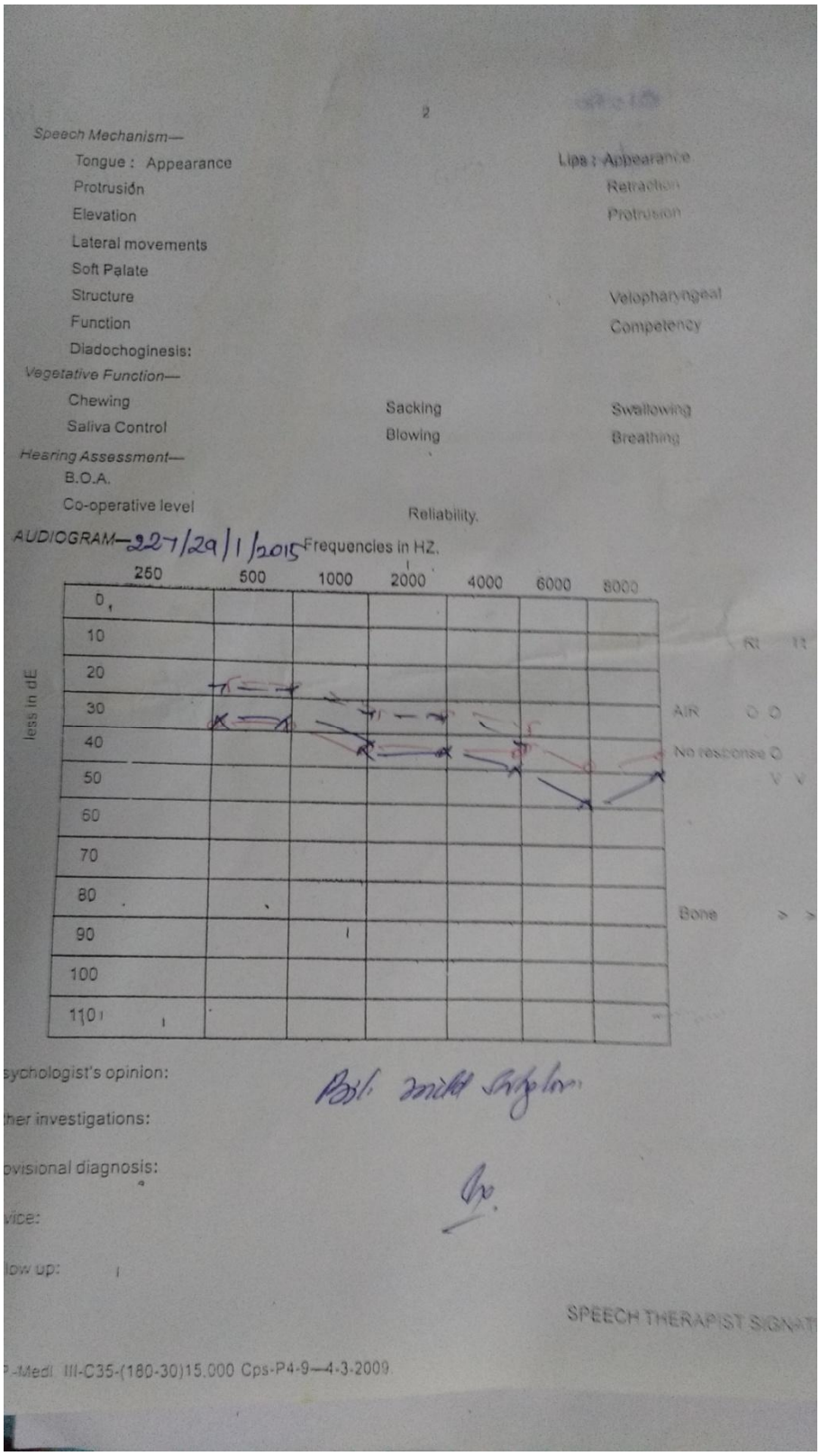
இடம் :

ஆய்வாளரின் பெயர்

PHOTOGRAPHS

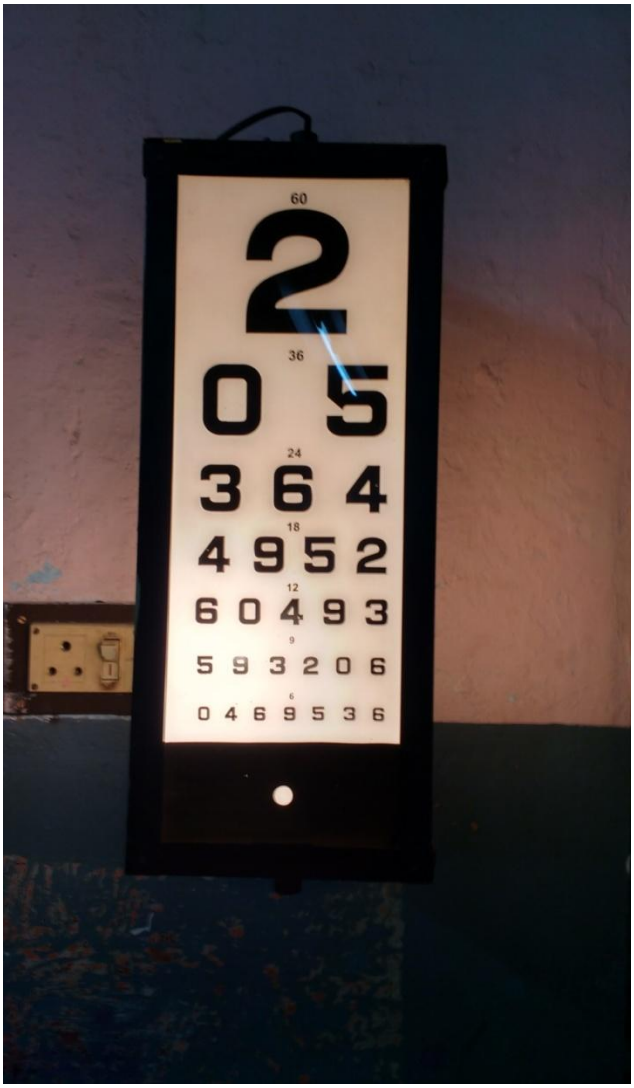
Photograph-1. ENT examination instruments.

Photograph -2. ENT examination cubicle.

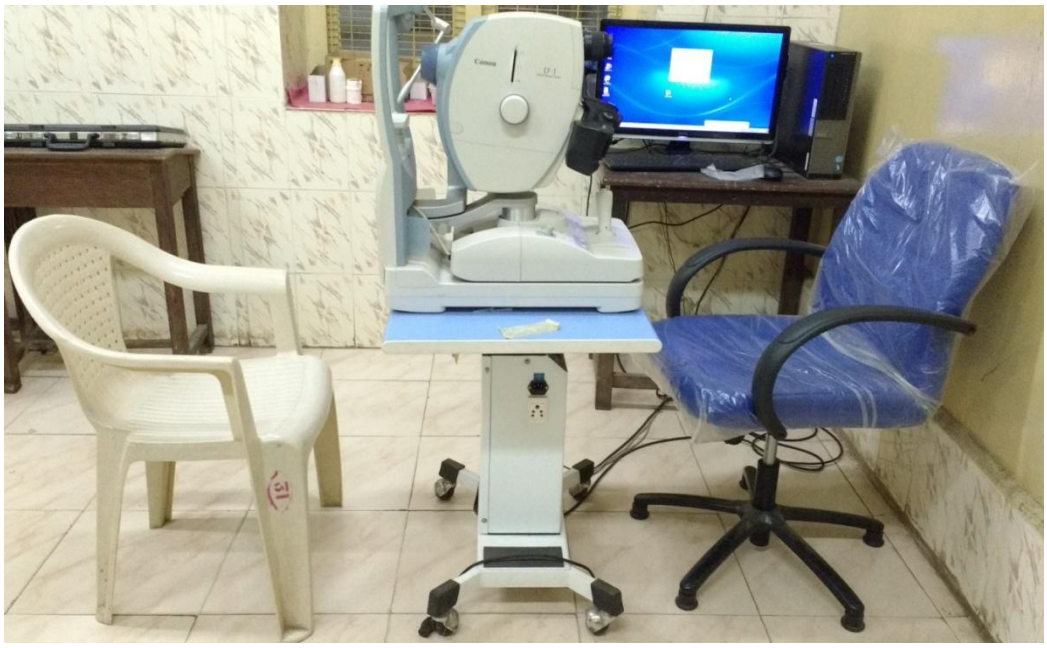


Photograph -3. PTA sheet

Photograph -4. Ophthalmoscope.



Photograph -5. Snellen chart.



Photograph-6. Fundoscope.

Photograph -7. Fundoscopic examination.

PHOTOGRAPH -8. PTA IN PROGRESS

PHOTOGRAPH -9. PTA MACHINE.

A STUDY TO CORRELATE INCIDENCE & ASSOCIATION OF SENSORINEURAL HEARING LOSS & RETINOPATHY IN PATIENTS WITH DIABETES MELLITUS

Dissertation submitted to the

TNMGR university, Tamil nadu, Chennai.

In partial fulfillment of the requirements for the degree of the M.S.

in

OTORHINOLARYNGOLOGY

UNDER GUIDANCE OF